AMATEUR WORK

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OUT DOOR ATHLETIC APPARATUS.

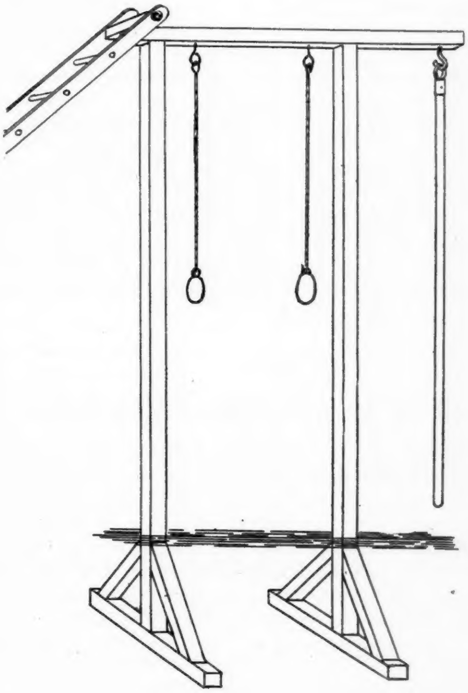
WALTER N. HANSCOM.

Physical training is too frequently considered a matter of interest only to young people, and the necessity of maintaining a proper physique by adults is, in these days of strenuous business life, rarely given proper attention, especially by those engaged in sedentary occupations, who are the ones most needing it. Gymnasium work generally means travelling quite a distance and the using up of the larger portion of an evening, with the result that it soon becomes tiresome and is eventually discarded for something more attractive. The average person in middle life is likely to be, therefore, in anything but good physical training, and unless afflicted with some noticeable ailment gives little thought to the benefits to be derived from a little regular daily athletic exercise.

The apparatus needed is not elaborate or expensive and requires no more room than can be found in the corner of many yards in the rear of residences excepting those in the crowded sections of large cities. In even these localities sections of the roofs of houses are railed in and floored for the purpose of hanging clothes, and the frames used for the clothes lines can be easily adapted for many excellent exercises.

The illustration shows a simple combination of athletic apparatus, permitting a variety of interesting movements, which can be supplemented by short distance running, making a sufficiently complete schedule as to enable those regularly following it to keep themselves in first class condition. It is well to emphasize the necessity of regularity of effort, as a few minutes daily, is of far more value than hours at irregular intervals. The great value of short distance running at moderate speed is only appreciated by those who have practised it. These facts are mentioned to show how easily one may engage in athletic training, and the writer hopes that what is here stated may influence those readers who are now doing little or nothing in this line to take up a few simple forms of exercise and the beneficial results will surely repay those doing so.

The apparatus included in the arrangement shown is that largely required to straighten the form, expand the lungs and develop the muscles of the arms, chest and back. Running will develop the muscles of the legs and abdomen, and expand the lungs, and as the distances are increased with practice, greater endur-



ance without undue fatigue will be acquired. The setting up drill of the regular army can also be included as a part of the course to good advantage, making altogether a well rounded schedule of training.

The framework consists of two upright posts 16 ft. long, 4 x 6 in.; a cross piece at the top 8 ft. long, mortised to the posts; a ladder with one end attached to one end of the cross piece and the other resting on the ground. From the other end of the cross piece is also hung a climbing pole or rope, or both if means and space will permit. Between the posts are hung adjustable flying rings, which may also have attachments permitting a trapeze to be substituted for the rings. A horizontal bar can also be attached to the sides of the posts.

All the woodwork should be nicely placed and the corners rounded off. It should be thoroughly inspected to ascertain that all points liable to cause splinters have been removed. A hand scraper will be useful in smoothing the surfaces. The bottoms of the posts should have cross frame work mortised to them, and this should be buried in the ground about two feet. All wood below the surface should be coated with a thick coat of asphaltum paint, and the earth firmly packed around it. All woodwork above ground should be given several coats of spar varnish, this being the only kind that will stand exposure to the weather.

The ladder should be of spruce and rather heavy. The climbing pole can be made from a length of 2 in. oak curtain pole, selecting one having perfectly straight grain. The fixtures for attaching the various parts of the apparatus can all be purchased of dealers in athletic apparatus, who can also furnish descriptive catalogues from which selection can be made. None other than general dimensions have been given, owing to the great variation in arrangement and sizes because of the limitations of space and means, but these suggestions and the advice of some carpenter will enable any one to put up a creditable arrangement and the subsequent pleasure and profit will more than repay them for having done so.

GLUE AS A BINDER FOR CORES.

The making of a core is matter which requires fully as much attention as the mold itself, and one is apt to think that as long as a core is made so that it will hold together and is well vented, that this is all that is necessary. Such an idea is wrong, says the "Brass World." A core for one purpose requires a different treatment from that of another, and to produce a core which will answer certain requirements, needs a careful understanding of the properties of the various binders.

The ideal core would be one which does not give off any gas at all when the hot metal strikes it. In addition to this, the core must be yielding so that the metal will not crack when it shrinks around it. Such a core material is unknown, and it is believed that the nearest approach to it is a core made of sand held together with glue. The virtue of the glue lies in its ability to bind the core together and, as far as known, glue is the best adhesive in existence. For a given weight, glue will hold more sand together than any other known substance.

This means that a smaller amount may be used for mixing with the sand than any other material, and with the accompanying virtue of giving off less gas when the hot metal strikes the core. It will, no doubt, be apparent that the less binder that is used in making a sand core, the less the amount of gas which will be given off. This is why glue is so useful in making the cores. So small an amount is used that very little gas is given off.

The method of using the glue for the manufacture of cores is to boil it up with enough water to dissolve it, and then add cold water until a very thin glue water is had. This is used to sprinkle the core sand mixture. The cores are then made in the usual manner and dried. If the cores are too hard, then less glue must be used in the water. The amount to be used can only be told by experience.

The advantage of glue is very apparent in the manufacture of small cores as the cost is not an item as it is in the use of a binder for large cores. For small cores, where there is little opportunity to vent them properly and little opening in casting for the escape of gas, glue will be found particularly serviceable. By its use it is possible to make a core which gives off practically no gas at all. This, of course, is on the assumption that a core can be used which is very soft. If trouble is experienced with cores of a small nature, core maker would do well to glue. Many know of its value but imagine that the cost is so much that it cannot be considered. As very much less can be used than in the case of flour, the cost is not so much as one might naturally believe.

Glue is very valuable in the case of large cores which are of such shape that they are apt to break in handling. By putting sufficient glue in the water which is used to wet the core sand, a core may be made which will stand a large amount of rough usage.

In casting the soft metal in plaster molds, it has been found that a very much thinner casting may be made if melted wax is allowed so soak into the plaster after it has been dried. The method of using this is to make the mold in the usual manner and then allow some wax to melt and permeate the mold. This can be done after it has been removed from the drying oven. This method causes the metal to flow with great fluidity, and every part of the mold will be permeated; therefore a much thinner casting than otherwise may be cast. Japan wax is what is used, as this answers the purpose and is a cheap form of wax. This method is now being used in one of the largest hollow-ware concerns with excellent results.

INDUCTION COIL MAKING FOR AMATEURS.

FRANK W. POWERS.

III. The Condenser.

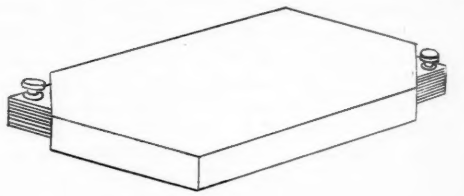
Owing to the long time required to complete a condenser to the working condition, it is described at this time rather than after the rest of the work on the coil is finished. The particular trouble referred to is the difficulty of drying out all moisture; this being necessary to guard against the possibility of sparking through the insulation and consequent failure of the condenser. One condenser made by the writer proved absolutely worthless because of the presence of moisture in the shellac, which was used as the dielectric. My experience has been that carefully waxed thin bond paper makes the best dielectric for amateur's use, two thicknesses of paper being placed between the sheets of foil.

Assuming, for the sake of illustration, that the condenser to be made is to be used on a spark coil rated to give a four inch spark, we find that the condenser requires approximately 3000 square inches of foil. It is necessary to state that condenser capacity is a variable quantity; no two condensers made from the same specifications having exactly the same capacity, but the results will be near enough to the estimated capacity so that no difficulty will arise from minor divergencies.

As the various uses to which a coil is put require different condenser capacities, it is desirable to make up the condenser in four sections with a plug or other large contact connecting device, which will permit of one or more sections being used as needed. This gives to each section 750 square inches, which works out nicely for sheets of foil 5 x 6 in. =25 sheets, each containing 30 square inches. To make an even division and also allow for loss or corners, 28 sheets will be used, 14 for each end, it being understood that the alternate sheets are connected as will be described. For the four sections there will be needed about 4 pounds of tin foil in sheets 5 in. wide, 1 ream of legal size thin bond paper and about 3 pounds of pure paraffine wax.

The legal size paper measures 8 x 14 in. and should be taken to a printer's and cut to 8 x 7 in. At the same time one diagnonally opposite corner should be cut off to a mitre cut of 45°. Measure off 3 in. each way from the corners and cut to the points thus obtained. The foil is then cut to the size 5 x 6 in. and one corner cut off, measuring 2½ in. from the corner for the points for the mitre.

To make up the condenser, an agateware pan 9 x 12 n. will be needed; also an iron pan about 10 x 14 in. and a squegee roller. The agateware pan is to contain the paraffine wax, and is placed in the iron pan; the space between the two being filled with water and the wax heated by means of the water. To heat the wax directly on a stove involves the risk of setting it on fire, which is avoided by using the water bath. If an oil stove is available it is preferable to use it rather than work over a cook stove, as considerable time is required and the work is rather "messy." A squegee well suited for the purpose can be made from a piece of glass tubing with thick walls, plugging the ends with wood and fitting a handle thereto. The ends of the tube should be ground smooth on a grindstone.



The materials being placed conveniently at hand, melt the wax in the agateware pan. When melted to quite a fluid condition, the wax is sufficiently transparent so that the foil and paper can be seen at the bottom. The wax should be boiled for at least half an hour before proceeding further. The paper should also be dried for several hours in an oven moderately heated, using care not to scorch the paper.

When all is in readiness, place two sheets of paper on the bottom of the pan, one at a time, and roll with the squegee roller. Then place a sheet of foil in the center of the paper with the corner overlapping the cut in the paper. Add two more sheets of paper, then another sheet of foil with the corner projecting at the end opposite that of the first sheet. Two more sheets of paper are followed by another sheet of foil; this time the corner projects at the same end as does the first sheet. The process is continued until all the sheets of paper and foil are laid for a section, the top layer being two other sheets of the paper. It will be seen that all the even numbered sheets of foil project at one end and the odd numbered sheets at the other.

After laying each sheet of foil on paper, roll smooth with the squegee to force out all air bubbles. An even, firm pressure, rather than a heavy one, is what is needed. The efficiency of the condenser is largely dependent upon the success with which the air is excluded, so the work should not be hurried.

After all the sheets are laid, the section should remain in the boiling wax for an hour or more. It is

then removed and placed between two pieces of thin, strong wood, or thick binders board, which have previously been well dried in an oven and also soaked in the wax, binding all solidly together with lineman's adhesive tape, except at the corners where tin foil projects.

To clean the wax from the projecting corners of the foil suspend in turpentine until the wax is all dissolved, and then clean off the turpentine by dipping in grain alcohol. The projecting corners of foil are then firmly pressed together, using care not to break them from the sheets of which they are a part. In the center is placed a strip of thin brass $1\frac{1}{2} \times \frac{1}{2}$ in. having a $\frac{1}{4}$ in. hole at about the center of the projecting corner. Punch a hole through all the corners of foil and place therein a binding post having a screw of small wire gauge, and screw the nut down tight. Copper or brass washers should be placed under both the head and the nut of the binding post to prevent tearing the foil. To the projecting brass strips are soldered the connecting wires, which can be done much more easily and safely than by attempting to solder the wires directly to the foil, as the latter melts easily and repairing is then a difficult matter.

HOW TO FIGURE HORSE POWER.

TERRENCE TRENHOLME.

Attempting to follow the empirical constants evolved for the steam engine led the pioneer gas engine designers so far astray that one and all dropped them forthwith, and seemingly they, nor their successors have ever come together since. The indicated horse power of any engine is equal to 1-33,000 multiplied by the product of the mean effective pressure, the area of the piston, length of stroke in feet and number of power strokes per minute. In the case of steam engines this is usually expressed by the formula

$$\text{H. P.} = \frac{PLAN}{33{,}000}$$

in which:

P. Mean effective pressure in pounds per square inch.

L. Stroke in feet.

A. Piston area in square inches.

N. Number of power strokes per minute.

Taking into consideration actual working conditions and allowing for drop in pressure from various causes, the results of this formula will be found to fall within close limits of error. But with the explosive engine so many disturbing factors are present that it is almost impossible to predict from cylinder dimensions, speed and fuel, what power a given engine will actually develop. The most that can be done is to say what it should produce, granted that the numerous conditions of effective working are complied with.

Assuming a given compression sufficiently short of the practical limit as not to involve any danger of spontaneous combustion, a speed that is neither unreasonably low nor excessively high, that the various parts have been correctly designed, that the mixture is good and ignition takes place at the proper point, that the resistance of the various ports and passages is not so great as to prevent the cylinder receiving an approximately full charge, a formula may be evolved which will, as above mentioned, show the best result theoretically that may be expected from an engine of given bore, stroke and speed.

By omitting the compression factor, the man who reads in a catalogue that the stroke and bore of a motor are of given dimensions, and R. P. M. are of specified number, may obtain approximate results by following this simple formula, the calculation in this instance giving the brake or actual horse power.

$$\text{B. H. P.} = \frac{D^2 \times L\,N}{18{,}000}$$

in which:

D. Piston diameter in inches or bore.

L. Stroke in inches.

N. Revolutions per minute.

The denominator varying according to the design of the engine and the character of the fuel.

By assuming a piston speed, this may be simplified to such an extent that, given the piston diameter, what any engine is capable of producing may be known with but little calculation.

General practice in four-cycle engines favors a piston speed of 500 feet per minute, in small stationary and marine engines up to 700 feet, and in automobile motors 800 to 1000 feet, so adopting 600 feet per minute as a mean, we have

$$\frac{2L \times N}{12}$$

$= $ piston speed in ft. per minute, or

$= 600$

$L\,N = 3600$

$$\text{B. H. P.} = \frac{D^2 \times 3{,}600}{18{,}000} = \frac{D^2}{5}$$

in which D, L and N represent the same values as above. Thus with this piston speed the horse power per cylinder would equal approximately one-fifth of the square of the bore. In other words, an engine, with a 5×6 in. cylinder, should produce 5 h. p. at 600 R. P. M., but this somewhat lower than the speed of the average automobile motor. The denominator four will approximately express the difference represented

by an additional one to two hundred revolutions per minute, will produce 6¾ h. p., and so on in proportion as speed increases.

For gasoline, E. W. Roberts, in the gas engine handbook, gives the following:

$$\text{B. H. P.} = \frac{D^2 \times L \times N}{13.500}$$

and this has been found to work out well in practice. But the engine builder who blindly follows any set formula is sure to be disappointed at the concrete result, and the majority of those who have started with a formula as a working basis, toiled over a long and weary road, full of vexatious obstructions being producing a motor that fulfilled expectations to any extent. Formulæ, generally speaking, represent maximum values obtainable under ideal conditions, and this is particularly the case where they have not been continually modified and readjusted as the result of experience extending over a number of years.—"Automobile Magazine."

WIRELESS TELEGRAPH RECEIVER.

AUSTIN M. CURTIS.

The following is a description of a wireless telegraph receiver which is very sensitive, yet simple, and which needs very little adjusting.

Make a base of ¾ in. mahogany, or other hard wood, 3½ x 3½ in. Plane it off smoothly and round off the top edges. In the center of this base drill a ½ in. hole, ½ in. deep. Shellac and polish the base. Next get a piece of glass tubing with 1-16 walls and an outside diameter of ½ in. Cut off a piece ½ in. long and smooth the edges by holding in the flame of a bunsen burner until the edges begin to fuse.

Get a piece of platinum wire one inch long, about 24 gauge, and solder it to a piece of No. 22 copper wire about six in. long. From a point on top of the base near one corner, drill a 1-16 in. hole at an angle, so that it comes out near the bottom of the ½ in. hole and ends there. See Fig. 1. Push the piece of No. 22 wire through this so that the part which has the platinum pointing upwards. Break up some good sealing wax into small pieces and pack these tightly around the point of platinum wire. Next heat one end of the glass tube until it is hot enough to melt the wax and force the tube into the hole. The wax will melt and adhere to the glass, making a perfect joint and leaving the platinum wire projecting above the wax.

Screw two double contact binding posts into oppoite corners of the base. Fasten to one of these the wire which comes from the bottom of the tube, and to the other piece of No. 24 copper wire which is coiled into a spiral for about ½ in. and the end left straight for 1½ in.

Get a cork to fit the top end of the glass tube and drill in it a hole about ⅛ in. in diameter with a hot wire or twist drill. Boil the cork in paraffine until it is thoroughly saturated.

Some glass tubing ⅛ in. in diameter and platinum wire .002 in diameter is needed. This will cost about 25 cents per foot and 6 in. is needed. Take a piece of the tubing 4 in. long. Heat the middle of it in a gas flame and draw it out until it is the shape shown in Fig. 2. Break the two pieces apart, leaving a minute opening. Put a piece of the platinum wire ½ in. long in each piece of tubing, leaving a short piece of the wire projecting outside of the small end of each tube. Heat the tube until the wire is sealed into the glass and the glass hardens. Next grind down the glass on

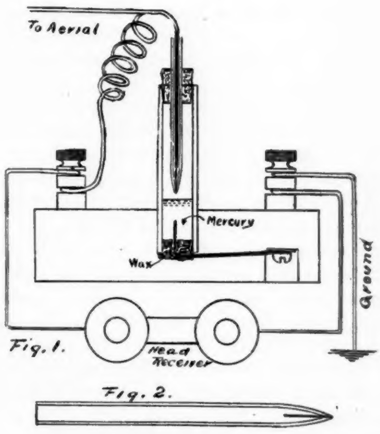


Fig. 1.

Fig. 2.

a dry whetstone until the wire flush with the glass. Fill the tube one half full of mercury, shaking it down until it touches the platinum wire inside the tube. Make about six of these points.

Put about one-half inch of mercury into the larger tube which is mounted upon the base. To the mercury add five or six small slivers of zinc. Put about ½ in. of dilute sulphuric acid (10 per cent) in the tube on top of the mercury. Now push one of the points in through the hole in the cork and put the cork in the tube. Put the end of the coiled wire into the point so that it touches the mercury. Connect a pair of head telephones of the highest procurable resistance across the two binding posts. A faint click should be heard when the wire is pulled away from the mercury in the point or touched to it. If no click is heard, grind the point down a little.

This receiver may be used untuned by connecting one binding post to the aerial wire and the other to the ground, with the telephones bridged across as above directed. It is particularly adapted, however, for working with a tuning coil.

Do not leave the cork in the tube all the time for the first three days or until all the zinc is dissolved in the mercury, otherwise the accumulated hydrogen gas may blow the cork and point out of the tube. If the point does not work satisfactorily, grind it down until it does.

With this receiver tuned the writer has received readable messages from a commercial station on a steamship over 500 miles away.

LARGE MARINE GAS ENGINES.

With the general development of the large gas engine there has come a natural tendency to apply it as a motor to nearly every variety of machinery demanding the effort of mechanical energy. It is to be expected, therefore, that the combustion motor, in more than one type, should be applied to the propulsion of boats; not only for driving the small, high-speed pleasure craft, but also vessels of larger size and less pretensions as to speed.

An article by Herr C. Stein in recent issues of the "Zeitschrift des Vereines Deutscher Ingenieure" reviews the practical applications which have been made of gas engines for propelling commercial vessels, and although the subject is in an early stage of its career it already demands attention and review.

The earliest attempts to use internal combustion motors for marine service involved the carrying of compressed illuminating gas, a freight boat called "L'Ide" having been so equipped to run between Havre, Rouen and Paris in 1885. The gas was compressed to 100 atmospheres, there being 80 tanks, each holding 22 cubic meters of gas, the total volume of gas carried being 1800 cubic meters. The 40 h. p. engine consumed 450 litres of gas per h. p. per hour, giving a speed of 10 kilometers per hour for 100 hours, or a ration of 1000 kilometers. The gas tanks themselves weighed 26,000 kilograms, and Herr Stein computes that this weight, if replaced by a tank of petroleum, would supply fuel for 1200 hours, or twelve times the period obtained with compressed gas.

By the use of modern benzine or gasoline motors the question of fuel is readily solved, and some very successful motors of this type have been made for marine use.

All such motors involve certain modifications to be made in the propelling machinery in use for steam propulsion, and these points are very fully discussed in Herr Stein's paper. Thus the gas engine is not easily reversed, and should be operated regularly at its normal speed, the speed changes being controlled by other means than by varying the velocity of the engine.

Reversals are effected either by changing the angle of the propeller blades, or by the use of reverse gearing, changing the direction of revolution of the propeller shaft. The shifting propeller blades are not found to work well for larger powers than 100 horse power, although this method is satisfactory for small boats. Herr Stein illustrates several arrangements of clutches for reversing the propeller shaft, some of these being combined with a pivoted tail shaft, so that the propeller can be raised out of the water when proceeding under sail.

The use of gasoline motors for marine service is necessarily limited, and hence the practicability of employing producer gas becomes a matter of interest. The development of the suction gas producer offers opportunity for the arrangement of a complete power gas plant for such a service, and Herr Stein describes such an equipment on a freight boat on the Elbe. This boat, the "Lotte," is 41 metres long, 4.6 metres beam, drawing 2 meters with a load of about 240 tons. This boat is fitted with a pair of balanced gas engines, the cylinders having the *vis-a-vis* arrangement, the suction gas producer being placed in an adjoining compartment, in order to protect the moving parts from the heat and dust. The engines develop about 100 h. p., this sufficing to propel the boat at a speed of about six kilometres per hour against the current. Experiments with this and other boats propelled by suction gas power show that the cost of transport falls as low as 0.64 pfennig per ton kilometre, or about 0.25 cents per ton mile, as against 1 pfennig for steamboat transport, and 3.2 pfennig on the railway.

The suction producer is especially applicable for use on shipboard, since an unlimited supply of water is available for condensing the impurities, tar, aud other volatile matter in the gas, and there is also ample opportunity for keeping the cylinders of the motors properly cooled. In general the conditions for operating the internal combustion motor are far more favorable on shipboard than on road vehicles. The question of weight is not of such controlling importance, and hence the various parts may be of ample strength. The difficulties from dust and dirt are absent, while the working parts may be made readily accessible. At the present time the larger sizes of gas engines have not been applied to marine propulsion, but for the propelling of boats of moderate size at the speeds common for ordinary river transport the engines now available have already proved their capability and high economy.

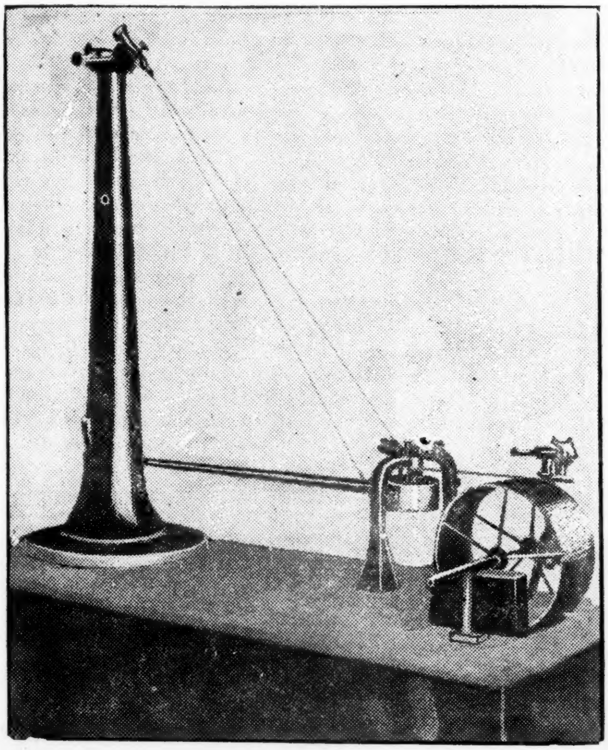
The Diesel motor has also been applied to marine propulsion, and it has the especial advantage of using heavy oil, petroleum and similar fuels directly in the cylinder, without requiring any carburetter.

Gas engine propulsion for boats may be said to be yet in its infancy, but the results thus far attained have been most encouraging, and there is every reason to believe that the use of internal combustion motors on shipboard will become widely extended.

THE SEISMOGRAPH.

RECORDS TIME AND INTENSITY OF EARTHQUAKES.

One of the most interesting places in Washington at this particular time is the earthquake or seismographic division of the U. S. weather bureau. There, in charge of Prof. C. F. Marvin, earthquake specialist and meteorologist, are kept the delicate machines known as seismographs, which record the time and intensity of any quake that may happen to pass this way, as well as a mass of data referring to earthquakes volcanic eruptions and other causes of disaster to humanity.



On one of the weather bureau seismographs was made a complete record of the great earth wave which brought death and ruin to the fair city of San Francisco.

The delicate needle of the seismograph had been tracing long, straight white lines on the gelatined surface of the record sheet Wednesday morning, when it suddenly became agitated at 8 o'clock 10 and 20 seconds, and began to make more or less elongated waves. At 8.25 o'clock the strong waves began, and the recording needle moved rapidly back and forth across the sheet. Then followed the most violent waves between 8.32 and 8.35 o'clock, 75th meridian time, as is shown by the record.

At one time the motion of the needle was so vigorous that its point went off the sheet, which is kept in motion by a clock machine, and the point did not return to the sheet until there was a secondary lull in the great disturbance. Then, when the needle had resumed its tracings, the earth vibrations and waves continued until 12.35, when the agitations ceased.

Each of the lines on the record sheet represents an hour of time, the movement of the sheet keeping time with the tick of the connected clock. The units of time are marked on this sheet, which is covered with gelatine, and thus the observer is enabled to tell just when the earthquakes began and when they ended by the markings made by the needle point.

The atmosphere which Prof. Willis L. Moore, chief

of the weather bureau, has installed in his department is said to be one of the best in the world. It is installed in a basement apartment away under the weather bureau building, far removed from the noisy hurly-burly of the streets, and is practically a mechanical recluse, only Prof. Marvin and the immediate observers being allowed to invade the sanctity of its subterranean home.

For purposes of exhibition and explanation a duplicate seismograph has been set up in a room adjoining the office of Prof. Marvin. This instrument has been shown and described to a large number of visitors since the San Francisco disaster.

ITS EXTREME SENSITIVENESS.

The extreme sensitiveness of the seismograph is shown in the following statement made by Prof. Marvin:

"The extreme sensitiveness to tilting is exhibited in several ways. The weight of the observer almost anywhere on the floor of the small room in which the instrument is installed suffices to tilt the pendulum enough to show on the record; a large displacement is produced by standing at one side of the pedestal. It has been noticed also that the weight of an ice wagon which stops daily to deliver ice at a basement entrance to a building causes a definite displacement of the trace of about one millimeter, which disappears when the wagon drives away.

There are no vibrations or oscillations registered, only a distinct elastic bending of the ground due to the load. This motion, moreover, is communicated through the foundation walls of the building. The distance of the wagon from the seismograph is about 20 feet; the asphalted drive and the basement floor are on the same level. The subsoil is a hard clay.

where an earthquake is causing destruction, only in greatly reduced magnitude.

UNWRITTEN EARTHQUAKE HISTORY.

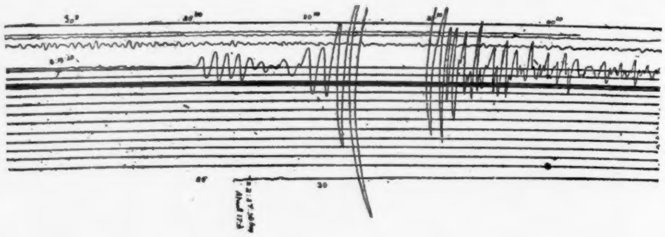
The professor gave the reporter a piece of unwritten earthquake history of recent origin and local application. He said that at 4.35 o'clock p. m. of April 10—eight days before the San Francisco visitation—a rather severe shock of earthquake was recorded on the weather bureau seismograph. Up to this time, however, nothing has been heard from the mysterious quake or its effects.

On another recent night three distinct shocks were recorded, but they remain unidentified as to effects, and it is not known whether the quakes occurred out at sea, or where. An earthquake was reported from Formosa on April 14, but it has not been connected with the mysterious quakes recorded at the weather bureau.

CAUSES OF EARTHQUAKES.

Prof. Abbe gives the causes of earthquakes in a statement which says, according to views commonly accepted in geology, the solid crust of the earth consists of an unknown depth of granite and gneiss, on top of which are five or ten miles of metamorphic and and sedimetary strata.

This crust is everywhere in a state of strain, due to various kinds of stress; in other words, the outward bulgings that make the continents and the mountain ranges, or the downward bendings that have made the ocean beds, represent strains that frequently become too severe for the rock to resist. Moreover, in special localities there are upward-pressing masses of lava or other plastic material that produce great local strain. In other places the strata that ages ago were tilted up to make a mountain, are still in a state of strain, and



The earthquake wave recorded at such a long distance from the real seat of trouble, was in the nature of a long, regular motion like a sea wave. The motion at San Francisco was quick and sudden, and therefore very destructive.

This violent agitation produced destructive strains, with the tendancy to shake buildings to pieces, whereas at a distance where the movement of the earth is slow and regular all portions of the building may follow the motion of the ground.

Prof. Marvin said, in illustration, that the passing of a rapidly moving railroad train produces a vibration of the earth similar to that produced at the place

notwithstanding the long interval that has elapsed, are occasionally cracking and sliding on each other.

These various stresses have produced the innumerable cracks that we see in the smaller beds of rock and the faults that the miner discovers in his attempt to follow up a vein of mineral ore. Even the tidal action of the sun and moon and the variations in barometric pressure and in the loads of snow and alluvium can produce appreciable effects.

Nearly all earthquakes are accompanied by a rumbling sound, due, I believe, to the small and rapid vibrations proceeding chiefly from the margins of the area over which the fault-slip producing the earth-

quake takes place. In some districts (Comrie in Perthshire; East Haddam in Connecticut; Pignerol in Piedmont; Meleda in the Adriatic, etc.) sounds without shocks are common during intervals which may last for several years, but slight shocks with sounds occasionally intervene, as if the sounds and shocks were manifestations, differing only in degree and the method in which we perceive them, of one and the same phenomenon.

In the great earthquakes the sound area is confined to the neighborhood of the epicenter; in moderate and slight shocks the sound area may even overlap the disturbed area. In the limiting case the disturbed area vanishes and the vibrations are perceptible only as sound.

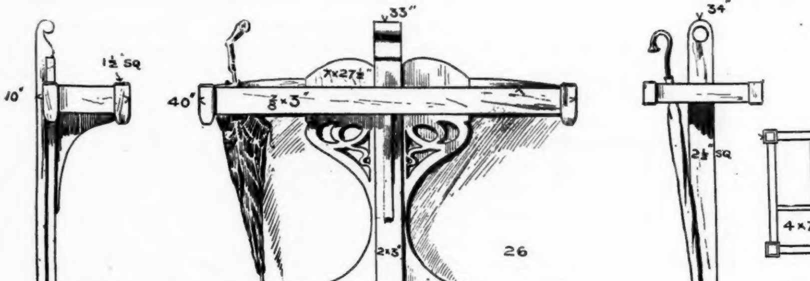
A weather observer describes the coming of an earthquake thus:

"The shock was preceded by a rushing or hissing sound, for three or four seconds, like the wind blowing through brush. It was followed by a rumbling sound, similar to a heavy wagon on hard ground. This lasted two or three seconds. Then came this heavy, jarring shock; two shocks were felt." — "Washington Star."

UMBRELLA STANDS.

PAUL D. OTTER.

It is an old saying that "all things come to him who waits," but many acquire "things" after they have secured the purchasing power. The handy man's wife acquires many articles after patient waiting on her husband's ability to "just get around to it," The umbrella stand, while not of vital importance, is not the least of many articles that some day we will get around to having. Meanwhile in the more pioneer days of home building the corner of the wall in the hall supported the umbrellas at various unsightly angles.



For the large family, the pattern shown in Fig. 1 will fulfil all requirements. The perforated center adjoining the middle part is cut from one length of board and the edges doweled and glued to each side of the post and flush with the front face. To the outer edges is secured the back part, as shown, entering the block corner seen in the side and front views. Before the divisions are placed, a ½-in. batten should span the back part across the front of the post and between the back corner blocks, being glued and firmly secured to each piece by brads. This will insure greater strength for the four-part back.

The bottom of the base is floored and may be zinc lined, or the bottom may have grooves running to the center hole, in which a pan is placed to receive the running water that may drip from the umbrellas. Inasmuch as umbrellas properly cared for should be opened out to dry, pans in the homes are hardly needed. Fig. 2 is planned for four compartments, but its entire length may be shortened for three openings if desired.

For a small stand Fig. 3 will be found serviceable to go in a certain corner. The arrangement for the top is the same as shown in the plan, compartment being built around a 2½ in. square post and the sides set in 1½ in. square blocks with chamfered edges. A dull oil finish will be found most satisfactory to apply to this character of furniture.—"Carpentry and Building."

Many who have wondered at the name of Portland cement will be interested to know that it originated in Leeds, England. A bricklayer named Joseph Aspdin patented an artificial cement in 1824 and called it "Portland Cement," owing to its resemblance to the famous building stone then quarried at Portland, England. As then made, it was a lightly colored mixture of lime and clay, which was afterwards ground. He started a factory for making it at Wakefield in 1825, and some of the cement was used in the Thames Tunnel by Sir I. K. Brunel, the famous engineer, in 1828.

A NINE FOOT SKIFF.

CARL H. CLARK.

The skiff which is the subject of the present article is of very simple and cheap construction. There are many persons who either do not realize their need of a boat until late in the season, or who put off the matter until then; for these this boat is well suited. For a cheap yacht tender, especially for use in shallow water, it is particularly well suited. It can be built by an amateur in about three days time at an expenditure of about six dollars for lumber, nails and paint. The one of which this is the copy was built by the author in about a week, working at odd times at a boat-house with few tools. The boat is 9 ft. long, 3 ft. 8 in. wide and about 17 in. deep. The material may be of any soft wood, such as pine, cedar or cypress; the latter is to be preferred, as it is tough, easily worked, light and cheap.

The main material required consists of: — Four boards 10 ft. long for the sides, of ½ in. stock, two 8 in. wide and two 10 in. wide; also two boards 10 ft. long, 6 in. wide and ½ in. thick, for rails, etc., and two strips 12 ft. long of 1 in. square, for ribs.

Two boards 9 ft. long, 6 in. wide and ½ in. stock are needed for the bottom stiffeners, and about 30 ft. of ½ or ⅝ in. stock, preferably the latter, in about 10 in. widths, for the bottom.

The construction is very simple, as will be seen from the illustration. The sides are in two pieces stiffened by the ribs; the bottom is laid crosswise, and in the corner between the sides and bottom are fitted the corner strips. The bottom stiffeners run fore and aft and strengthen and protect the bottom.

Fig. 7 gives the pattern of the sides, formed of the 8 and 10 in. boards, the curved seat being cut out of the wider board. The edges of the boards should be carefully jointed and the outline cut out as shown. The boards should be fastened together temporarily with cleats on the inside, care being taken to keep them clear of all the points marked on the plan. The several lines should be drawn across square, on the side which will be the inside of the boat, for future use in placing the ribs. The seams between the two boards should be close and smooth.

Fig. 9 is the shape required for the form at the widest point; it is made of rough boards but must be strong and accurate. Fig. 8 illustrates the board for the stern, of ⅞ in. stock, cut to the shape shown, and the edges bevelled slightly, to fit the bevel of the sides.

The widest place in the boat occurs between the two 8 in. spaced lines at the middle seat. The form should be placed here and held in place by lightly nailing; the two sides should then be carefully bent around. Great care must be used in the work not to break or split the boards, and they must be bent slowly. A light frame may be made, a trifle larger than the stern, to slip over the after end of them, to hold them in place, leaving only the forward ends to be bent around. A cleat may be fastened across the forward ends and a rope passed around, and used for drawing them together. When the sides are sprung into place the bow will be found to be much more pointed than is desired; it must then be forced out by a board put across at about the after side of the forward seat, until the width here is exactly 3 ft. outside; the deck view should then appear as in Figs. 2–4.

The stern board should be fitted and secured in place; the sides may be forced down and held by driving the frame further forward. This should force them down firmly into place, and after painting the joint they may be fastened with screws or long nails. The frame should, however, be left in place until the sides have "set" and some of the spring is removed, as otherwise the joint may be opened slightly.

The forward ends of the side boards are brought to within about ½ in. of each other, leaving this amount all around the curved ends to be filled up by the stem. The stem on the inside must next be fitted. It will be necessary to do this entirely by trial on account of the curve of the bow. If a curved knee can be obtained the stem can be made in one piece, otherwise it can be in two pieces, as shown in Fig. 5. The bearing of the sides on the stem should be about 2 in., to allow good fastening. The sides are fastened on with brass screws and galvanized nails. All surfaces should be painted before putting together. Before finally fastening, great care must be taken to see that the boat is symmetrical and true, and should be held true by braces, to avoid any chance of changing shape.

The corner strips, as shown in Fig. 6, are next to be fitted; these strips are 2 in., wide and, as may be seen from the figure, are bevelled and fastened so that the bottom boards fit upon them and inside of the side boards. They are fastened about ⅝ in., from the lower edge of the side boards; at the after end when the curve is greater, they may require a saw cut at intervals to make them bend more easily. They are fastened to the sides with galvanized wire nails, clinched.

The ribs are now to be fitted from the 1 in. strips. They are cut out to fit over the corner strip as in Fig. 9, the object of this being to prevent the sides from warping. The ribs are fastened to the sides, one on each side of the lines already marked, the middle of the rib on the line. They are fastened with the nails clinched over on the inside of the rib, two nails should be drawn through the lower end into the corner strips and carefully clinched. These pieces should

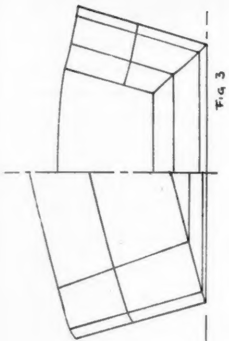


FIG 3

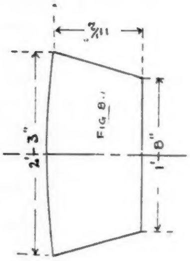


FIG. 8
2'-3"
1'-8"


FIG. 6

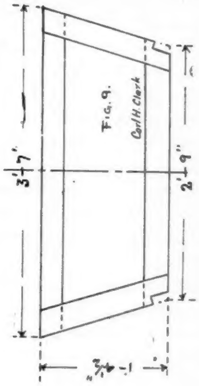


FIG. 9.
Carl H Clark
3'-7"
2'-9"

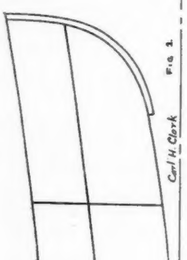


FIG 1
Carl H Clark

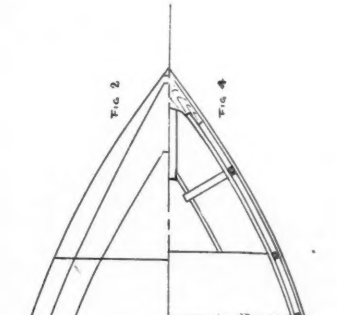


FIG 2
FIG 4

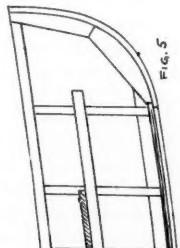


FIG. 5

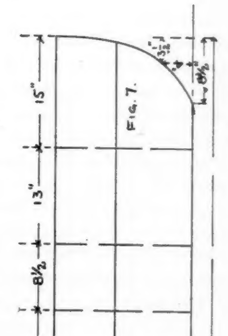


FIG. 7.
15"
13"
8½"
13"
13"
8"
13"
13"
12"
5"
9'-5½"

make the sides very stiff and avoid any chance of splitting.

The bottom boards are laid crosswise, fitting between the side boards and resting upon the corner strips. The planks nearest the ends are fitted first, working toward the middle; the ends of the boards are bevelled to fit inside the sideboards, and the edges are made straight, with just enough bevel to make up for the curve of the bottom. The joint is well filled with paint and the boards nailed to the corner strips and also from the outside into the ends of the bottom boards; this nailing in the two directions makes a very strong joint. The nails for this purpose should be about 1½ in. long. The last board should be fitted before the adjoining boards are nailed, as the sides may then be sprung out to let this board down into place, otherwise the slight bevel would prevent its entering.

The bottom stiffeners are fitted inside and outside and are through fastened; they stiffen the bottom and prevent the joints from working. The forward ends of the side plank are now finished off square across and the false stem fitted; the latter is of oak of proper size to make a finish and is steamed and bent into place. It butts against the forward end of the outside bottom stiffener, which is tapered to meet it. A stern band should be fitted to cover the joint and take the wear.

The gunwales are 2 inches wide, and are let ½ in. into the tops of the ribs and well fastened; at the ends pieces are put between them and the sides to hold them parallel, and knees are fitted as shown in Fig. 4.

The seat braces are 1½ in. wide and are fitted about 7 in. down from and parallel with the top of the gunwale; they should run from stem to stern. The seats rest upon these braces. The seats are ⅝ in. thick, the after one 12 in. wide and the other 8 in. wide. The forward seats are fitted in the position shown, bearing against the ribs, and act as braces to keep the sides apart; the ends are notched to fit around the ribs; the bearing should be upon the ribs and not upon the plank. The after seat is fitted in the same way and fastened to the fore and aft braces.

The small skeg under the stern adds to the rowing qualities of the boat; it is of ⅞ in. stock with a cleat on the back extending up on the stern. Rowlock blocks are secured on top of the gunwale and fitted with galvanized rowlocks; foot braces may also be fitted.

All the seams should be fairly tight, but any which are not may be fitted tightly with cotton and puttied. The entire boat should be given two coats of paint.

Seven foot oars are the proper length for this boat, and with the addition of a ring bolt for the painter the boat is now complete. This boat should be very satisfactory as it is light, easy rowing, and has excellent carrying capacity.

FAHRENHEIT THERMOMETER.

According to Sir Samuel Wilkes, Fahrenheit constructed his thermometer from one made many years before by Sir Isaac Newton. "In the Transactions of the Royal Society for 1701 will be found the paper written by Sir Isaac Newton, who was at that time Secretary to the Society," says Sir Samuel. "He invented an instrument for measuring the degrees of heat in fluids by taking a tube and filling it with linseed oil. On this he marked the freezing point as zero by putting the tube in ice, and in the same way he marked the point when placed in boiling water. The very awkward scale which we now use is evidently that of Newton, for, the decimal system not being then in use, he took the number 12 to denote the heat of the body; this he found, and made it the starting point of his scale, both upward and downward.

"It was some time after this, that, for the sake of convenience, the degrees were divided into two, and thus the body heat was 24 above zero and boiling point 53. When, many years afterward, Fahrenheit made his instrument and used mercury instead of linseed oil, which was far more convenient, he again divided these degrees, into four so if the number be multiplied accordingly we have 212 for the boiling point and 96 for the body heat.

"Fahrenheit, finding he could get a lower temperature than freezing, made this point zero, which brought the number 8 of Newton's to 32 of Fahrenheit. In this way the thermometer was constructed."—"Chicago News."

TRUING AN OILSTONE.

If your oilstone needs leveling, says the "Blacksmith and Wheelwright," scrape it with the edge of a piece of glass. A piece of glass can always be obtained when perhaps the ordinary methods of rubbing down are not available or would take too much time. If one end or one corner of the stone stands higher than the rest it is easier to reduce to a general level in this way than by the ordinary methods which make the surface flat, but cannot easily remove a slope to one end or one side.

A slight inclination in any direction causes the oil to run off the stone, and it is advisable, therefore, always to leave the stone slightly hollow so that the oil will tend to run to the middle when it is left standing. The greatest wear occurs, not in the middle of a stone but near the end at the places where the movement of the tool is reversed. It is, therefore, chiefly a small area at the extreme ends which require scraping down and sometimes a little in the middle and along the sides, to take some of the hollowness out.

HINTS FOR MACHINE WOODWORKERS.

CHARLES CLUKEY.

FILING BAND-SAWS.

One very common fault of beginners in scroll band-saw filing is that of bearing too heavily on the file, and I may say that I have lately seen a man who has been filing more or less for the last dozen years who had never discovered why his saws got so badly out of joint. It is a fact that scroll bands need very little jointing if they are filed with the proper care and frequency. A small saw does not have to be very dull before it will refuse to cut freely, and the reason of this is because of its small teeth. So if the saw is filed as often as it should be, a slight stroke of the file will restore its cutting points without taking away much of the substance of the the teeth. But when a man gives a full, strong stroke to a little tooth it is quite perceptibly shortened, and at the same time takes fully twice the time that a light stroke requires, thus resulting in twice the time and half the efficiency of the proper method.

A SOLDER OR A BRAZE.

Another perplexing thing in connection with the band-saw, and it is not confined to scroll bands either, is that sometimes the man who makes the brazes does not understand the difference between a solder and a braze. If the irons or the torch are not hot enough to flux the solder with the steel, thus making an alloy, the two surfaces of the steel are apt to be soldered together and in appearance present a good joint. In such a case, however, the solder is apt to come apart when the saw is folded or while the joint is being dressed.

In this connection may be added a word about the mistaken idea that borax should be put in the joint between the lap of the saw. With that practice there will be generated a certain amount of gas which will partially prevent a perfect flux of the silver and the steel. Put the borax on the outside and a sufficient amount will find its way in from the outside.

CUTTING BELTS LENGTHWISE.

One of the mean jobs for the millwright is to cut a large or thick belt lengthwise. The writer spent some little time sweating over this kind of work before he caught on to the simple trick of splitting them on the rip-saw, although he had often cut the ends off with a fine handsaw.

LOOSE PULLEYS AND BABBITT METAL.

Loose pulleys with babbitt metal for bearing surfaces are easy on the shaft, but they have a mean way of wearing out so that they have to be rebabbitted occasionally. That this is to some workmen a puzzling job is evidenced by the length of time required to accomplish the task and the wobbly results after it is done.

The proper and simple way is to bore a hole the size of the shaft in a short piece of plank, and after turning a plug to a neat fit, slip this board on it and face up in the lathe to a true surface. Then turn a shallow groove that will just receive the rim of the pulley in a snug fit. If the hub projects farther than the rim it will be necessary to turn down into the middle of the plank far enough to accomodate the hub so that the rim will enter the groove. In the event of the countershaft having been taken out it is as well to put the board on this and babbitt the pulley on the shaft itself, but in the absence of the shaft a piece of wood turned to the same size will do as well.

When putting the pulley in place one or two thicknesses of paper should be pasted around the shaft before pouring the metal so as to give the bearing a running fit. The paper should not be pasted all over but merely a little streak at the end so that it will stay in position. Sometimes it is hard to get the pulley off the shaft and the looseness of the paper will facilitate this operation. But understand the paper must be smooth and tight when the pouring is done.

One of the common troubles of babbitted loose pulleys is that the babbitt gets loose in the housing and causes a bad knocking before there is much wear in the bearing proper. This can be prevented by having the pulley good and hot when the babbitt is poured so that it will shrink about as much as the softer metal and so be tight forever after.

THE USES OF CHALK.

A neat trick known to most machine-shop men but not to many woodworkers, is to rub chalk on a file to keep it from filling up with the metal being filed. This knowledge is especially valuable in case of reducing a shaft by means of a file.

And speaking of chalk, it is good to use as an oil extractor for old belts. Rub the whiting into the belt as thoroughly as possible and then pack it closely in the same material and let stand for a day or two. The object of rubbing it in is to induce capillary action which will draw the oil from the saturated belt into the dry chalk. Of course all the oil will not come out but the belt will be dry enough for good service.—"Wood Craft."

It is commonly believed by non-technical persons that anything called "steel" must necessarily be stronger than iron. As a matter of fact, poor steel is miserable stuff, not to be compared with decent wrought iron, though the latter is a scarce material nowadays.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

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A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

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Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisments, or changes, intended for a particular issue, must be received at this office on or before the 10th. of the previous month.

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JUNE, 1906.

The devices, attachments, and methods used by one mechanic to accomplish some certain result, are more than likely to be useful to others, and for that reason we hope all readers will make a point of sending us descriptions of anything in this line which they may use themselves or learn of others using to good advantage. The general co-operation of readers to this end would provide information of the greatest mutual advantage. Do not fail to do this simply because it may not be convenient for you to make an inked drawing; pencil sketches and a simple description are all that are needed. And do it while the subject is fresh in your mind; if you postpone it you are liable to forget. For such descriptions we will give liberal payment either in cash or in tools from our premium list. Here is an easy way to fill up your tool chest.

In the previous paragraph mention is made of one way in which this magazine can be made of greater interest and value to its readers. Here is another:

We wish to learn the opinions of our readers as to methods by which this result may be achieved and accordingly make the following offer:—For the best letter received during the month of June stating why the reader likes the magazine, and giving three suggestions as to what changes or additions would make it of greater value to the readers, will be given the choice of premiums from our premium list to the number offered for five new subscriptions. For the next best letter, the premiums for three new subscriptions; the third best letter, the premiums for two new subscriptions. For the ten next best letters, the premium for one new subscription. Each letter should contain not over 200 words, be written on only one side of the paper, with margins at top, left side and bottom.

This is a very liberal offer, and it is earnestly hoped that a large number of readers will find it convenient to favor us with their views on these subjects. We have in contemplation some important plans for developing the magazine, and the information received from these letters will be of material help in enabling us to carry them out. In complying with our request readers will benefit directly, and we have made this liberal offer to encourage a general response. Do not postpone writing, but give the matter your early attention.

A number of letters and orders have been received without the signatures or addresses of the writers. It is hardly necessary to state that it is impossible for us to fill orders or reply to letters unless we know who send them. If your orders for back numbers have not been filled, jog your memory a little, and send a postal repeating the order, date sent, and *sign it.*

A visitor at the Brussels automobile show, so it is related, by the "Horseless Age," after looking for a long time at the large jars for stationary accumulators and asking what they were used for, bought one of the jars, explaining that he wanted to pickle a haunch of deer in it. The incident was the cause of much merriment among the exhibitors of the show.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

I. Types of Engines—Advantages of Each Type.

The great increase during the last few years in the use of automobiles, power boats, and other units of small power, has led to the expenditure of a large amount of time and money in the development of the gas and gasoline engine. These engines are particularly well suited to their present uses, being as they are, self-contained, easily installed and operated and reasonably reliable when in good hands. Since there is no external generator or boiler, and no fuel to be handled, they are easily kept clean, and as the supply of fuel is automatic and continuous, they run with the minimum amount of care, and little labor is required other than the lubrication and the regulation of the fuel supply.

The principle upon which the operation of the gasoline engine dependsis the fact that a body of gas tends to expand upon the application of heat, and if allowed to do so, has the power of doing work. The heat is contained in the fuel as potential energy and is freed by the combustion, causing a rapid rise of pressure in the body of the gas. When this body of gas is confined in the cylinder of the engine it is capable of doing work upon the piston.

The gas engine is of the type technically known as internal combustion engines. This name originates from the fact that the combustion of the fuel and the consequent generation of heat take place directly in the cylinder of the engine instead of in a separate chamber or boiler, as in the steam engine. In the latter engine the heat is generated in the boiler, raising the pressure of the contents, which are carried to the engine and allowed to expand, thus utilizing the heat. The steam engine is thus complicated by the boiler and extra piping, and the necessary care to feed the fuel and maintain the proper quantity of water in the boiler. These duties usually require the entire attention of one man, while with the gasoline engine one need only give an occasional oversight.

Gas or gasoline engines may be divided into two general classes, the two cycle, and the four cycle, the principles of operation of which are quite distinct. The former, or the two cycle type, is the simpler in operation and will be considered first. In either type of engine there are four operations to be accomplished; (1) drawing in the fresh charge, (2) compressing and firing the charge, (3) expansion of the ignited charge, and the absorption of its power, (4) expulsion of the burnt gases. The completion of this series of events is termed the "cycle"

The general outline of the two cycle engine is shown in Fig. 1, where *A* represents the cylinder, *B* the piston, *E* the connecting rod, *CD* the crankshaft and pin. *G* is the crank case, which must be air tight. F is the inlet opening into the crank case, which is provided with a valve allowing the gas to enter, but not allowing it to return. *H* is a passage leading from the base into the cylinder at the inlet port *I*, which is

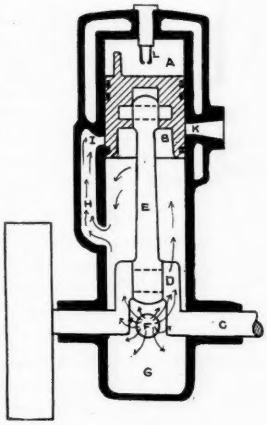


FIG. 1.

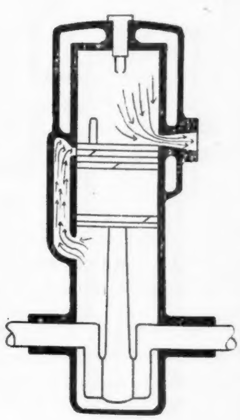


FIG 2.

above the piston when the latter is in its lowest position, as in Fig. 2; at *K* is another port called the exhaust port which opens into the air; at *L* is some means for producing an electric spark to ignite the charge. For the operation, suppose the piston to be at the bottom of its stroke, and to ascend; this action will create a suction in the air-tight crank-case and draw in a charge of vapor, as shown in Fig. 1. On the next downward stroke the non-return valve on the inlet *F* prevents the charge from being forced out again, and it is compressed slightly, banking up the pressure in the passage *HI*, the outlet of which is shown closed by the piston in Fig. 3. When the piston nearly reaches the bottom of its stroke it uncovers the inlet port *I*, and the charge rushes in and fills the cylinder, as in Fig. 2. Before, however, any of the new charge can escape through the exhaust port *K*, which is also open, the piston has begun its next up stroke and covered the inlet port, so that the cylinder is now full of fresh gas. The upward stroke continuing, the charge is compressed into the space above the piston, until the latter reaches its highest point, when the compressed charge is ignited by the spark at *L*, Fig. 1. This ignition produces a powerful impulse

due to the heat generated by the combustion, which drives the piston down. When the piston has nearly reached its lowest point, as in Fig. 3, it uncovers the exhaust port *K* and allows the burnt gases to partially escape. A moment later in the stroke, the inlet port *I*

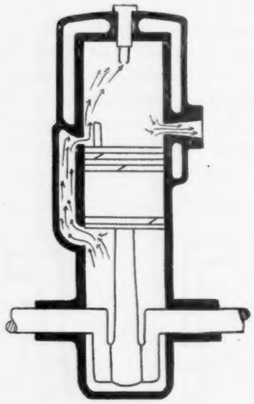


FIG. 3.

is uncovered and a fresh charge is admitted from the crank case which fills the cylinder, as before, and drives out the remainder of the burnt gases. This new charge is then compressed, and a new supply drawn into the crank case, and the operation continues.

Following the sequence carefully it will be seen that the cycle is completed during every revolution, or for every two strokes. It is thus called the two-stroke cycle, or as commonly stated, the "two cycle." This

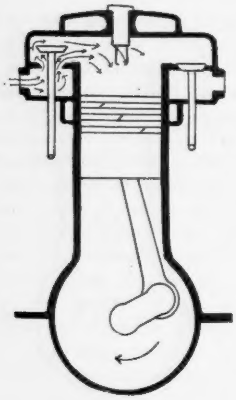


FIG. 4.

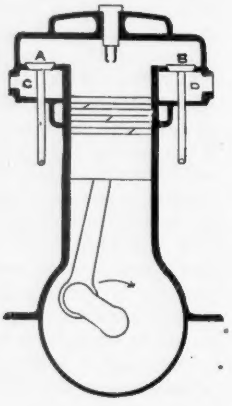


FIG. 5.

cycle gives an impulse or working stroke during each revolution. The momentum of the flywheel is depended upon to carry the piston up on the idle or compressive stroke. The projection on the top of the piston is a deflector or shield surrounding the inlet port to deflect the gas upwards and prevent its rushing directly across the cylinder and out of the exhaust port. The exhaust port is directly opposite and somewhat higher than the inlet port, in order that the pressure may be reduced and the burnt gases partially escape before the fresh gases are admitted. The relative size and position of these two ports is the key to the success of the two cycle engine. It will be seen that the piston acts as its own valve, so that this engine, from its very principles, is valveless. The claims of some engine builders as to the "valveless" features of their engines are therefore entirely superfluous, as it would be difficult to build this type of engine in any other manner.

In the four cycle type of engine the admission and exhaust of the vapor are controlled by mechanical means. In Fig. 5, *A* is a valve opening into the cylinder from the admission chamber *C*. *B* is a similar valve opening from the cylinder into the exhaust chamber *D*. The other portions of the engine are substantially the same as those of the two cycle engine, with the exception that the crank case does not require to be air tight. The valves are controlled from the main crank shaft.

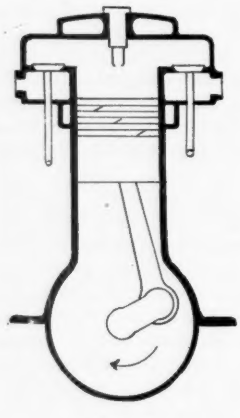


FIG. 6.

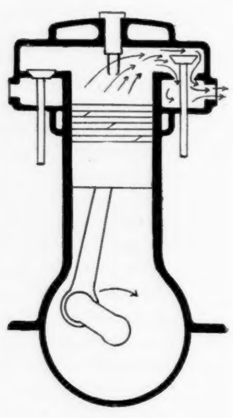


FIG. 7.

For the operation, suppose the piston to be at the top of its stroke and to travel downwards, as in Fig. 4; the inlet valve *A* is open and the suction draws in a charge of fresh gas, filling the cylinder. On the next upward stroke, shown by Fig. 5, both inlet and exhaust valves are closed, and the gas is compressed into the space above the piston. When the piston reaches the top of its stroke the compressed charge is fired by an electric spark, or other means, and it expands, driving the piston down as in Fig. 6 and furnishing the working impulse. On the next up stroke, illustrated by Fig. 7, the exhaust valve *B* opens, and the burnt gases are forced out by the piston through the exhaust port. The cylinder is now clear and ready for the admission of another fresh charge on the next downward stoke of the piston.

This cycle is completed in two revolutions, or four strokes, and is called the four stroke cycle, or "four cycle". There are three idle strokes and a working stroke for each cycle, thus giving an impulse for every alternate revolution. The flywheel must be heavy enough to carry the piston over the three idle strokes.

ADVANTAGES OF EACH TYPE.

The two cycle engine has the advantage of extreme simplicity, as there are no valves or other external moving parts which are likely to require adjustment. Since it receives an impulse for each revolution, more power may be obtained from the same size engine than is possible in the four cycle type; it might seem that since the two cycle engines receive twice as many impulses as the four cycle, twice as much power should be obtained, but this is by no means so, as owing to the superior regulation of the four cycle types the difference is much less. The more frequent occurrence of the impulses does, however, allow a lighter flywheel and produces a smoother running engine with the least vibration.

The valveless feature of the two cycle type gives rise to some uncertainties and irregularities in the action of the engine. The action of the gases in the cylinder is more or less uncertain, as it is hardly to be expected that the inflow of gases will continue until just the right time to fill the cylinder and no more; it is entirely possible either that some of the exhaust may not have time to escape, or that some of the fresh gases may pass over and out of the exhaust. It is hardly possilble, also, for the new charge to entirely scour the upper parts of the cylinder, and some waste gas is sure to be caught in the cylinder, thus diluting the new charge. The driving out of the burnt gas by the fresh mixture while some combustion may still be going on, frequently results in the ignition of the new charge and the explosion of the reserve in the base, producing a back explosion, causing irregular action, and even stopping the engine.

There are also some disadvantages which might be termed structural ones. While the working parts are very simple, they are entirely enclosed and not easily open to examination. Since the crank case requires to be air tight any leakage around the crank shaft bearings from natural wear, causes a loss of crank-case pressure, and consequent loss of power. Any leak around the piston and rings will allow the partially burnt gases to pass down and deteriorate the quality of the fresh gas in the crank case. If the workmanship on the engine is originally poor, as in some of the cheap engines, these troubles are likely to occur soon, and in any case they are apt to occur after prolonged use.

The four cycle type, although more complicated, is surer and more certain in its action, as the behavior of gas is exactly controlled. The idle stroke allows the cylinder a very short time to cool between explosions.

As the flow of gases takes place only on each alternate revolution, and then during a whole stroke instead of in a puff, the four-cycle engine may be run at a higher rate of revolution. Owing to the mechanical regulation, there is less chance for loss of fuel and the economy is greater. No enclosed crank case is necessary, and the working parts can be more easily cared for. On the other hand, the three idle strokes require a very heavy flywheel, and since the impulse occurs on each alternate revolution, the four cycle engine must for the same power, be larger and heavier than the two cycle. Each explosion or impulse is much heavier than in the two cycle, and tendency to vibration is consequeutly much greater.

The two cycle engine, in spite of the more or less theoretical disadvantages, has reached a high state of perfection, both as to reliability and economy, although in the latter respect it is probably not the equal of the four cycle. As a general conclusion it may be stated that for small, light engines where economy is of small moment and especially for those of one cylinder, which as a rule receive little care, the two cycle type is to be preferred; while for engines of larger size, where economy of fuel is a consideration, together with great reliability, the four cycle type should be employed.

RAISING SHIPS WITH ACETYLENE.

An ingenious method of raising sunken ships has recently been devised by M. Pierre Hurzy, says the "Electrical Review." The system depends upon the use of calcium carbide for setting free gas when brought in contact with water. At suitable points in the vessel cases of carbide are placed, which, when brought into contact with water, force out the latter, thus emptying floats after they have been attached to the ship. The success of the method depends upon obtaining an equal buoyancy at different parts of the vessel.

For this purpose cans of carbide are placed at the points which are to be emptied of water. They are fitted with explosive caps, which are set off simultaneously by an electric current. In this way the case is ruptured, water is admitted and the emptying of all compartments begins simultaneously. It is suggested also by the inventor that the method can be used to advantage in operating floating docks. After such a dock has been sunk and has taken in the vessel to be lifted, the water is expelled from the ballast chambers by means of the acetylene gas set free from the carbide.

Lampblack is a soot, usually prepared by igniting resin or pitch, leading the smoke and vapor through an oily tube, where the oily products condense and then into a series of chambers, in which the carbon is deposited, the purest carbon being found in the chamber furthest from the point of combustion.

INTERCHANGEABLE BORING BAR CUTTERS.

The troubles experienced by some shops with their boring-bars and cutters if recorded would make a book of several chapters. This is written with the hope that it will be followed up by some of your contributors with their experiences.

The boring-bar L, shown in Fig. 1, I find unsatisfactory because the hardened edges of the cutter *G*, at *A*, cut the softer metal of the bar *L*, and thereby allow the cutter an uncertain amount of side-play in the slot, which is always doubled in the hole being bored. When this side-play becomes so great as to allow the cutters to be bore a hole larger than standard size, it is necessary to mill down the flats on the bar and make a new set of cutters throughout, which is very expensive, as the bar has to be out of service while this is being done.

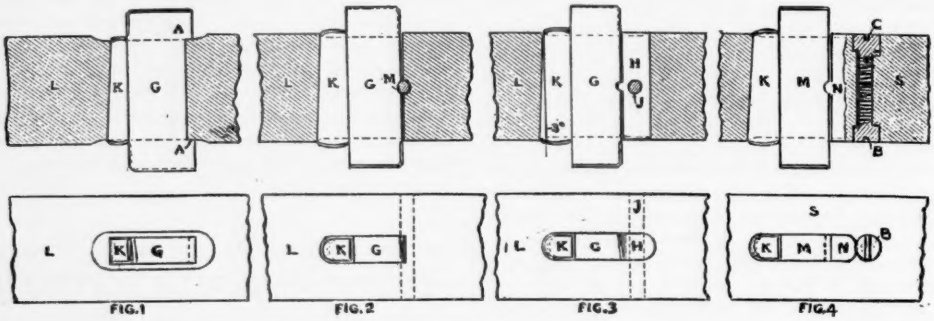


FIG. 1 FIG. 2 FIG. 3 FIG. 4

In Fig. 2 we have the boring-bar which is theoretically correct, practically a failure, for the reason that it is next to impossible to drill the hole for the hardened pin *M* exactly through the center of the bar *L*. I think any tool-maker will agree with me in this statement, if he has ever tried to drill a ½ in. hole through the center of a 2-in. round bar of tool steel at right angles with the axis. I have overcome the defects of Figs. 1 and 2 by constructing our boring-bar as shown in Fig. 3.

I make all of our bars, keys and centering pieces of low grade tool steel, and our cutters of Jessop steel. All the work on these bars, except locating the centering pieces, drilling and reaming the taper pin holes *J*, and finishing the end of the keys *K*, is performed on the milling-machine.

For grinding-cutters for these bars I use a short bar *S*, made of tool steel, with hardened centers, and with a slot as shown at Fig. 4. It was necessary to make this bar first, in order to originate what I will call the master cutter *M*.

The key *K*, master cutter *M*, centering piece *N*, and screws *B* and *C* were hardened and assembled in the short bar *S*, as shown in Fig. 4. It was next put into the grinder, and the master cutter *M* was ground until both ends were trued up. The micrometer height gauge was then set to just touch the ends of the master cutter *M*, and the reading noted. The master cutter was then changed end for end in the slot and the height again taken. It was then readily seen which way and how much the centering piece *N* was out of center. By continued grinding, testing and adjusting of screws *B* and *C*, we were enabled to set the centering piece *N* so that the convex projection was within 0.0001 in. of the center.

The same master cutter is used to locate the centering pieces in the boring bars as follows:—

The boring-bar *L* is mounted on dead-centers and straightened if necessary; then the centering-piece *H*, master cutter *M*, and hardened key *K* are put in place and the key driven up lightly. The michrometer height gauge is again brought into service, and by tapping the centering piece *H* with a light hammer the master cutter is brought to a position where the variations in the micrometer readings taken from both ends of the master cutter is within the 0.0001 in. limit.

The key *K* is then driven up tight, and the master *M* is again tried with the micrometer, and if still within the limit the bar is ready for drilling for the taper-pin *J*.

After fitting the pin, the centering-piece *H* is hardened, and if the hole has contracted in the hardening, it is lapped until the taper pin *J* will enter to the same depth as would previous to the hardening.

If, on the contrary, the hole has expanded, the hole in the bar will have to be reamed larger.

Boring-bars and cutters made in this way will bore within 0.001 in., if the bars are kept straight and are a good fit in the supporting bushings. This, I think, is near enough where holes are reamed by hand after boring.—A. V., in "American Machinist."

A WALL CABINET.

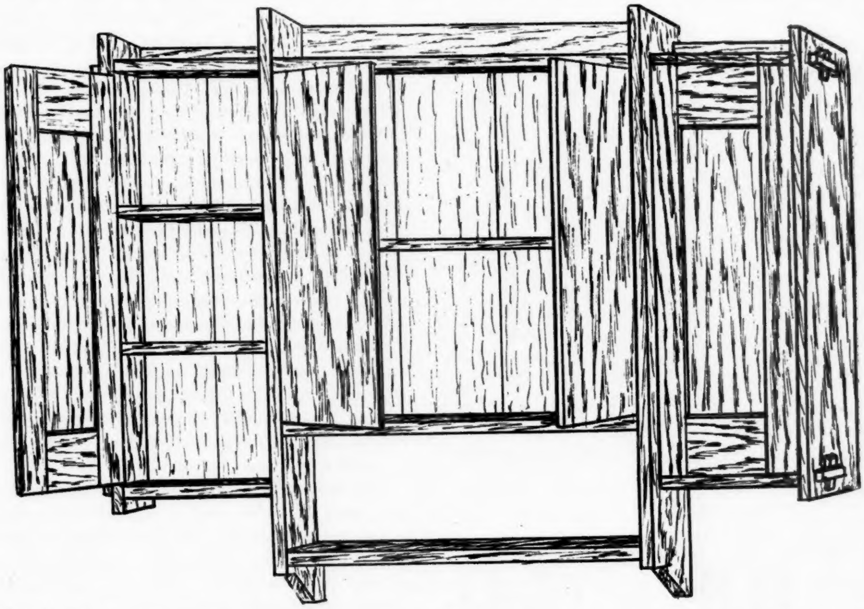
JOHN F. ADAMS.

Although wall cabinets are not now used as much as formerly, yet in many homes one like that here described would be found useful for storing the numerous small articles required in the den, library or bathroom. It is best made with wood of light weight, and stained as desired, so as to avoid a cabinet too heavy to easily suspend on the wall. The stock used should be about ⅝ in. thick.

To obtain the necessary strength the framing is somewhat peculiar. The top piece over all the cupboards is in one piece 38 in. long, 10 in. wide over the center, and 9 in. wide over the end compartments. The two pieces forming the sides of the center division are 30 in. long and 10 in. wide. They are cut through from the back to a depth of 6 in., the upper cut being 3 in. from the top ends, to receive the top board, which is cut from the front to a depth of 4 in. the cuts spaced to give 18 in. between the two side pieces. Care must be taken in sawing the slots on the sides not to break off the overhanging piece at the top. It is also advisable, after the cabinet is finally assembled, to cut out a piece at the back about ½ in. deep and 3 in. long, and fit a piece of the same size, which is nailed in place, one end to the top, the other end below the slot and the center to the top board.

The cross piece under the center cupboard and the shelf underneath are each 18⅜ in. long and 10 in. wide, allowing 3-16 in. at each end to fit in grooves cut in the sides. The height of the cupboard is 18 in. and the shelf is 6 in. below the bottom of the cupboard.

The two outside cupboards are 21 in. high, and 7½ in. wide. The pieces forming the outer sides are 25 in. long and 9 in. wide. The ends rise above the top board 1½ in. and drop 1 in. below the bottom of the under board. The projecting tenons, to receive the pins, may be single ones 4 in. wide or double ones 2¼ in. wide, as preferred, but this must be decided before beginning construction, to prevent error in cutting. It



will be found that much aid can be obtained from drawings made of each piece one-half or one-quarter full size. All dimensions are marked thereon and checked off to insure corrections. The time taken to make such drawings is more than made up by the rapidity with which the work can be followed by their aid.

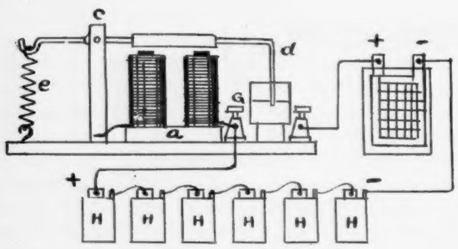
The pieces under the end cupboards are 9 7-16 in. long and 9 in. wide, allowing 3-16 in. on the inner end to fit into a groove cut in the space between the end and center cupboards, and 1¾ in. for the tenon through the outer side piece. The rear edges of all the pieces mentioned should have rabbets cut to receive the backing, matched sheathing ½ in. thick being used; the rabbets should be, for stock of this thickness, ¼ in. wide and ½ in. deep.

Above the cupboards at the back are fitted pieces, as shown in the illustration, that over the center being 3 in. wide, and over each end 1½ in. wide. Also, a piece is needed under the center cupboard which should be 6 in. wide, if no rabbets are cut for it, or 6½ in. wide with rabbets.

The shelves for the cupboards can be located to suit the convenience of the maker, and are 8½ in. wide in the center and are 7½ in. wide in the end cupboards. The doors may all be panelled as shown for the ends, or smooth as in the center. If made smooth there should be cleats 2 in. wide and ⅜ in. thick, fitted to the ends on the inside. They should be glued in place, the drying being done in clamps. The usual fittings of hinges, knobs and locks will need no description.

AUTOMATIC SWITCH
FOR CHARGING ACCUMULATORS.

Make a little horshoe electro-magnet out of a piece of ¼ in. round soft iron rod, each limb being 1 in. long and yoke also 1 in., Fig. 1 *a*. Wind this with six turns of No. 20 d. c. c. Over this pivot a soft iron armature 1 in. long, *b* having a lever extension at the pivoted end *c*, and a curved piece of bare No. 16 copper wire, *d*, at the other. The poles of the magnet must be perfectly level, and to prevent the armature adhering when the current is off should have a disc of stamp paper stuck on the upper surface of each. A little metallic cup, in which a drop or two of mercury is placed, is fixed just under copper wire so that when the armature is pulled down by the magnet the copper wire should dip into and make contact with the mercury.



This mercury cup should be connected to a terminal leading by a stout wire to the + terminal of accumulator. The lever end of the armature is hooked on a small spiral spring *e* of sufficient tension to pull the armature away from the poles of the magnet, when the voltage of the battery falls to 5 volts, but not powerful enough to detach it as long as the volts exceed 5. One end of the magnet wire is connected directly to the iron of the magnet, say at *f*; the other end goes to the terminal *G*, to which the positive pole of the charging battery *H* is connected.

Finally, the negative pole of the battery is connected to the negative terminal of the accumulator. Now the battery and accumulator being duly coupled up to the switch, as described, the armature is gently depressed, so as to cause the curved copper wire to dip into the mercury cup. Now the current passes from the battery, round the magnet wires, through the pivot to the mercury cup; thence through the accumulator, completing its circuit to the battery; and as long as the voltage exceeds 5v., retains the armature down, and the copper wire in the mercury. Directly the voltage falls below, the pull of the spring overcomes the pull of the magnet, and releasing the armature, breaks the circuit.

METALLURGY OF TIN.

In the metallurgy of tin, its first process is that of grinding the ore. The ground ore is then washed, which removes impurities, tin being such a heavy metal that it is most easy to wash away the earthy matter, and even some of the foreign metallic ores often contained with it. When other metals of about the same specific gravity are contained in the tin ore, further treatment is essential. The ore is then roasted in a reverberatory furnace, whereby the sulphur and arsenic are expelled. It is then mixed with fuel and limestone and heated strongly in the reverberatory furnace, so as to bring the whole into the state of fusion, which is maintained for upwards of eight hours. The lime unites with the earthy material still mixed with the ore and flows with them into liquid slag, while the coal reduces the oxide of tin to the metallic state.

The reduced tin falls by its own weight to the bottom, and is, at the end of eight hours, let out by tapping a hole in the furnace, which had been filled with clay. The tin yet is impure, containing iron, copper, arsenic and tungsten. That it may be purified, the blocks of tin are placed in a furnace and moderately heated until the tin melts and flows into the refining basins, while the greater part of the foreign metals remain in the solid state. The molten tin in the refining basins is then stirred with sticks of green wood, whereby gases are given off and the metal is maintained in a state of artificial ebullition. The upper parts of the contents of the basin are oxidized and removed from the surface, while the greater part of the foreign metals collect at the bottom.

The tin is allowed to partially cool, during which process it separates into zones, the upper consisting of quite pure tin, while the under is so impure it is necessary to return it to the furnace and melt again. The layer of tin is removed into molds in which it is allowed to solidify. It is then marketed as block tin, the purest specimens being called refined tin.

METOL=HYDRO AND ITS ADVANTAGES.

CHESTER F. STILES.

When a plate has not been developed far enough, we find in printing that the light penetrates even the densest part of the negative before the shadows of the print are printed deep enough. Such a plate is thin all over, with detail in abundance, but density is lacking. The fault is called " under development." Opposed to this fault is the lesser one of " over development, " where the tones seem all right and make excellent prints provided one prints long enough. Some plates have been seen by the writer which seemed almost opaque. They take hours to print by strong light with ordinary paper, and a number of minutes with rapid bromide papers.

Of course the above remarks refer to errors of development only. The exposure itself has been assumed to be fairly correct. The error of under-development is remedied by "intensification"; that of over-develment is corrected by "reduction". In this article only the first process will be treated.

In the early daysof photography, intensification was done with nitrate of silver. With the advent of the gelatine dry plate came identification with mercury. The base of this intensifier is bichloride of mercury (corrosive sublimate,) which is placed in hot water till no more of the salt will dissolve, thus making what is known as a saturated solution.

The plates to be intensified must be thoroughly fixed and washed, so that no developer is left in the film. If not, the careless worker reaps his reward later in the form of indelible yellow spots. No satisfactory method has been found for correcting stains. To avoid them, washing from half to three-quarters of an hour is none too long.

The chemistry of the process of intensification is quite simple. We place the plate in a diluted solution of the corrosive sublimate and the black silver image turns white. The silver image has been replaced by a white compound of mercury and silver. Various agents are known which blacken this compound. Among these is ammonium sulphide, which forms an intense black compound of mercury, much blacker than the original silver image. Hence the intensification.

In practice we place the well washed plate in the diluted mercury solution and bleach till white throughout. A thorough washing is necessary to remove the mercury. Next apply the blackening solution and wash again when sufficient density is secured. If only a partial intensification is desired, bleach the negative to a grey appearance instead of white.

For ammonium sulphide may be substituted a solution of sodium sulphite or of ammonia. The latter gives the strongest intensification of all. It also helps contrast by blackening the darkest parts in a greater degree than the lighter portions. It is, therefore, a gain in quality of intensity, a flat plate resulting from over-exposure.

The time for intensification is immediately after washing. The film is porous and will take the intensifier easily. If an acid hardening and fixing bath has been used, the film is very hard to penetrate. It is well to double or even triple the washing times in the process, or, better than that, avoid acid hypo and hardeners. You will be surprised to see the hardening and lack of frilling which plain freshly made hypo baths will promote.

Notice an over-exposed plate carefully. You will see a wealth of detail from highest light to weakest shadow. The plates have a brownish cast and pass light in all parts, so that the prints are weak and flat. You can usually improve these plates by selecting a contrasty intensifier.

On the contrary, an under-exposed plate will not stand intensification to advantage. In this case, the contrast is wrong on the plate in the first place, since the shadows did not develop at all, while the high lights have piled on density by the prolonged development. Now, if an intensifier is applied, it still further increases contrast. A double error in tones is then present. To diverge a little from our subject: —In every case that you can duplicate an under-exposed plate, do so in preference to intensifying. The best place for an under-exposed plate is the ash barrel.

The bleached mercury image may be developed in an old developer if desired. Use an old tray and keep it for this purpose alone. Discarded developer is better than the stronger and fresher solutions.

The mercury chloride will dissolve better in water if some ammonium chloride (sal-ammoniac) is added. Equally good is muriatic acid. Mercury chloride dissolves very slowly, and the additions above quicken the speed of solution. Besides, the muriatic acid will destroy any traces of hypo which may cling to the plate from the fixing. The mercury seems to cling to the gelatine film and is hard to wash away. It is wise to use a weak solution of citric acid after washing from the bleaching solution, and before the darkening solution.

All the above methods are two solution processes. They have the disadvantage that one does not know the density until the process is finished. Yet, as in all photo operations, experience teaches, and a careful worker will have few real difficulties.

We will now take up an intensifier much used abroad on account of its simplicity. It is known as the Lumiere intensifier, and consists of a mixture of mercury iodide and sulphite of soda. In this intensifier hypo

matters little. A slight washing suffices, after which we intensify directly, watching the density as it increases. The application of an old developer at the end of the process will make the image permanent.

The great advantage of this intensifier is its direct method. If only a partial intensification is desired, one stops at the density desired. No fixing is necessary after the development, although the developer is allowed to act. The product is common in this country under the name of "Scarlet Intensifier," from the brilliant color of the mercury iodide, and in common with all mercury compounds, is poisonous internally.

The uranium intensifier is one which has gained much ground of late. Since the deposit is red, density is improved greatly by its use. Make two solutions of eight ounces water each, using 25 grains uranium nitrate in the first, and 3 grains red prussiate potash in the second. Mix 1½ ounces of each with ½ ounce glacial acetic acid. Skilful workers may intensify locally, for the uranium deposit is soluble in ammonia. It may be removed by painting with a brush dipped in the ammonia solution. Take a hint from the experience of others and try local intensification on an old plate until you get the hang of the process.

"Agfa" intensifier, made by the German photo chemists, is obtainable at most photo supply stores. It is a colorless liquid, containing a mercury salt in solution, which adds density directly to the plates. One part of the solution is added to nine of water, making working solution. It works directly, and the plate slowly gains a deposit of grey tint, which is quite nonactinic.

Many other processes are known, a large portion being variations of the mercury baths. It is possible to bleach in copper sulphate with bromide of potash, after which silver nitrate is the blackening agent. Potassium bichromate is used to bleach the image in another process, and the blackening follows by redeveloping.

In general, we may remark that cleanliness is the key to perfect intensification. Whenever one process is succeeded by another, have the intermediate washing complete. This is the greatest secret in intensification.

WORK FOR THE INVENTOR.

Some of the astounding facts revealed by recent agitations over the London fog which covered that great city like a black pall during the latter part of last December, says "Modern Machinery," may furnish our Yankee genius with a greater incentive to get to work upon the solution of a problem long under consideration.

A week of fog in London costs the railway companies $1,000,000 and the cabmen $6000 a day. The loss to shopkeepers is beyond calculation, but reaches millions. The excess of gas used on a foggy day would supply a town of 40,000 people a whole year, showing that the gas companies at least are benefited. One hundred and fifty million cubic feet of gas is consumed during one day of gloom, costing over $100,000. The Hon. Rollo Russell has estimated that in consequence of foul atmosphere Londoners are put to from $15,000,000 to $25,000,000 in unnecessary expenses annually and in winter they are deprived of three-quarters of the sunshine they are entitled to. The agitators claim that the cause of this state of affairs is due to smoke from 600,000 houses and 14,000 factories. According to the careful calculations of an expert these smoke-laden chimneys pour forth 7,000,000 tons of smoke-laden air, that carries 300 tons of coal in suspension. Can nothing be done to relieve London of this plague, every return of which brings an alarming increase in the death rate through accident and from diseases of respiratory organs.

BATTERIES FOR GAS ENGINES.

Each style of battery has certain fields of its own to fill but it becomes sometimes necessary for the owner of a gasoline engine to decide which he shall use, says "The Canadian Thresherman." In favor of the dry battery is the low cost, and the fact that there is no solution to spill around, and the weight is light compared to the wet cells. The objection to them is that they cannot be used on long runs without weakening, and then have to stand over night to recuperate.

The proper way to use them is to have two sets, making a double battery, and have them connected to a double throw switch. This enables you to run a few hours on one set and then throw in the other set and while it is being used the first set is regaining its strength. With a wet battery this is not necessary as they will continue to give a steady, equal spark until they give out almost at once. On account of this fact it is not necessary to use a double battery with them. Wet battery manufacturers can supply a special style that is liquid tight, but any of the ordinary types can be made so by wrapping the joint of the cover with common electric tape.

Liquid tight cells are required for engines that are moved around so that the jarring and shaking will not spill the liquid. In our opinion the best method of ignition is to use a battery for starting the engine and by means of a double throw switch, throwing from the battery to an automatic sparking dynamo, after the engine is up to speed. As made now, the high grade dynamos give good results and are to be depended upon for a good hot spark that will ignite charges, that the battery will sometimes fail to do. The ignition part of an engine is of the utmost importance, and must get frequent attention and care to get good results from it.

HARDENING STEEL.

S. W. GOODYEAR.

As a constant reader of your valuable paper I come in contact monthly with opinions and formulas and advertisements of books and recipes for hardening and tempering steel, and still the inquiries continue to come for best methods. "How shall I harden and temper granite drills?" says one, and at once come answers which advise use of rain water, brine, boiled linseed oil and salt. "A drop of water will prove to be ruinous." Now there must be in this, as in all other mechanical processes, a foundation fact. Good work in hardening is done by the use of rain water, well water, spring water, water saturated with salt and water in which have been a thousand and one nostrums, and oil is used in the same way, clear in great variety beside linseed, with additions of a variety of other things, all with good results sometimes, and with occasional "bad luck" as steel varies from what it should be or, begging the pardon of the hardener, the treatment is not just right.

If of two diametrically opposite methods of heating and cooling it can be said that both bring first-class results, one equally as good as the other, notwithstanding the advocate of each method persists in standing up for his own and denouncing the other as worthless and ruinous, is it not fair to suppose that the real foundation on which successful hardening depends lies deeper than any particular formula? A secret? No, a fact, free as sunlight, and that fact is that hardening depends upon heat and sudden cooling.

Rock drills—granite drills—let us make a good one. Don't forge it to shape at a low red heat, as someone advises. Get a good mellow heat and be sure the heat is even, clear through, not a heat got too quickly and only at the surface. Do not continue mauling and hammering down to a black heat, but stop with heat remaining sufficient so that if the steel used is of a right temper for first-class rock drills it will harden like glass at heat at which hammering ceases, at the thin edge.

In fact, I once watched for an hour a hand mining drill dresser who sharpened worn drills as they came to him from the mine, entirely with the hammer and a brush of the file, and hardened and tempered them, for there was no second operation of tempering, by dropping them into a bath of salt water, right from the anvil and hammer, without reheating, and by my test with a file every one was hard, and by testimony of users of the drills no better drills had ever been used by them. I saw no broken drills.

"Then," says somebody, "you advise this?" I say, "No ; but it is one way, and there are as many apparently different ways as there are different steels," and just here comes up one of the most important factors in the whole matter—*i. e.*, right steel for any particular use. The man who says, "Follow my formula for heating, and use my bath for quenching, and no matter what the steel is, you will succeed," has certainly another guess coming, for if he has been so fortunate as to always happen to use a steel for which a good, bright orange color is safe, he will some day strike one which, with the same heat treatment will go to pieces like so much glass, and the chances are that it will be the very steel he should have used all along.

I said "fortunate," did I not? Yes, and in that very way are thousands of steel users measuring success—*i. e.*, "the steel which will bear most abuse, highest heat for hardening and still not break, but do good work," is held up as a standard, while there are some who measure success by comparatively ultimate value of hardened pieces, as quoting one satisfied steel user who was sounding the praises of a steel new to him, when asked to give some definite statement of comparative superiority over the old standard imported steel he had sworn by and thought he could not live without.

"Three weeks against three days." Another who, after years of practice with best average production from certain dies being fifty thousand, tries a new steel and says, "five hundred thousand." "High speed steel?" "No, but steel which can be annealed and tempered by old-fashioned methods. High speed steel has its uses, and is doing marvellous work, such wonderful work as to make us doubt the veracity of some who keep tabs and publish records of speeds, feed, depth of cut and aggregate removal of stock in given time, lifetime of tools, etc., and still investigation will show them to be in the main true.

I will wind up by stating that, as I see it, the subject of treatment of steel is inexhaustible. Best in steel is none too good; so with treatment; and to be fitted up with all the best appliances for proper hardening is desirable, and in no other way is it likely that money is expended more judiciously, and still I have before me the two-days-old vision, not of a stolid, self-reliant, self-possessed hardener, pumping wind by hand on an old-fashioned portable forge, one of the pump-handle variety, with a hatful of fuel, and it not charcoal, but coked bituminous coal, to heat as bad a tool to harden as often comes to the lot of any man; little fire, little wind, but constant care, measuring the stroke of the lever as carefully as though a life depended, and it did, *i. e.*, the life of the costly tool. "She's coming, coming good," says the man at the lever as he peeps through the thin layer of coals over the intricate shaped face of the tool being heated. It is a forming tool some 3 in. wide by 1 in. thick by 5 or

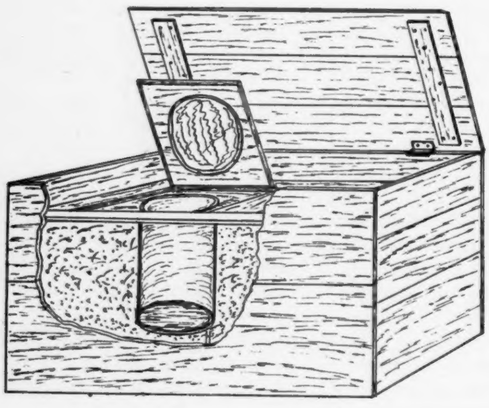
6 in. long, intent being to harden some 2 or 2½ in. in length of the working end, and "she does come," first a perceptible red and gradually changing color to that beautiful shade which delights the successful hardener.

"Coming good," says the man. Said I, "Yes, and it is about there," and out it comes and into clear water and is kept there, not until cold but until hardening has taken place and then the old hardener violently works the pump handle some more, making the sparks fly, and held the tool over the fire to equalize the heat, and with the tool as hard as glass, and a heat just inside of the tempering to straw color, the job is done. Methods most primitive possible, and still this man had it under his hat to do a good job, no matter what the facilities were; from start to finish he had been as alert as would have been the most experienced trout fisherman with a big one hooked and playing to land him. Such men are prizes.—"Blacksmith and Wheelwright."

FIRELESS COOKING.

FREDERICK A. DRAPER.

The expression "fireless cooking" is not strictly applicable to the process to be here described, but is sufficiently near it to make it applicable as a short title. For many years the "hay box" has been in regular use, and has proved of great utility for certain kinds of cooking. While not of particular value in many lines claimed by its over enthusiastic advocates, it is, nevertheless, worthy of careful consideration in every household, and this is especially true on hot summer days when a morning fire can be used to produce a hot meal to be served up in the evening.



The principle involved in the operation is that of retained heat. The food to be cooked is put in a suitable utensil upon the stove where it is thoroughly heated. It should remain upon the stove long enough to bring the contents to the boiling point, and continue at that temperature for an interval varying with the kind of food being cooked. The heated utensil and food are then placed in an insulated box constructed to prevent the loss of heat, where they remain for a number of hours. The contained heat in the food serves to thoroughly cook it in such a way as to retain the best flavors of the food, and it will be found that tough meat can be made much more palatable by this process than by any other method of cooking.

The experienced housekeeper will readily understand the limitations of this method of cooking. Stews, boiled meats, vegetables and cereals are the kinds of food particularly successful. Baked beans and roast meats must be browned in a hot oven before being placed in the cooker; otherwise they will lack the color desired in dishes of that kind. As there is no evaporation of the liquid contents from the vessel, it is necessary to have the portions of food exactly as desired when served upon the table. It is necessary, therefore, to have color and flavoring ingredients exactly proportioned at the beginning of operations.

The first attempt with an experimental apparatus made by the writer was that of a 10-pound ham which was boiled for 30 minutes in a ten quart enamelled ware kettle; placed in the cooker at 10.30 A. M. and removed at 6 P. M. The ham was found to be thoroughly cooked, tender and having a most delicious flavor. Corned beef, beef stews, and vegetables were afterwards tried with marked success. One peculiarity about cooking vegetables in this way is that they do not break up as when boiled upon the stove.

The essential feature of the cooker is perfect insulation of utensil and contents, and the better the heat is retained the more satisfactorily will the food be cooked. For a small family a cooker having two or three compartments for holding kettles of different sizes will be quite sufficient. The shape known as a stock kettle is preferable as, having straight sides it can more easily be thoroughly packed.

In making a cooker it is first necessary to select the kettles to be used therein, and for a two compartment cooker, one kettle holding ten or twelve quarts and one holding four quarts, will be found to serve most purposes.

A two compartment cooker holding kettles of this size will require an outside box 36 in. long, 20 in. wide and 20 in. deep, inside measurements. Such a case can be easily made up from two shoe packing boxes, selecting the boards with matched joints. This is divided into two

compartments by a division board 16 in. high placed 20 in. from one end. An inside top is then fitted to cover the division board and extending the full length of the box, leaving a space about 3 in. between the top of the inside cover and the top of the box. This is shown in the accompanying illustration.

Holes are then cut in the center of each division of a size to admit the cooking utensils with about one-half inch space between the utensil and the edge of the hole. Discs of wood are cut out the same size as the holes cut in the inside cover. Sheet tin or the sides of some large cheese boxes are cut and bent to cylindrical form to fit inside of the holes, and the wooden discs are used for the bottoms of these cylinders.

After nailing the cylinder firmly in place the box is turned bottom side up, and the space between the cylinders and sides of the box is firmly packed with chopped cork, sawdust, or old newspapers. The bottom of the box is then nailed on. If chopped cork or sawdust is used it will be desirable to first paper the inside surface of the box and cylinder to prevent the fine particles of cork or dust from sifting through any fine cracks which may have been left.

Strips of wood two inches wide are then nailed around the top side of the inner cover. These strips should have the inner edges cut to a bevel of about 45 degrees. Two covers are then made to fit inside these strips with the edges to correspond with the bevel on the strips. The cover should be carefully fitted to make the joints as tight as possible. A top cover is then made for the box, the two covers being much on the same plan as that of an ice chest and serving the same purpose.

In using the cooker it is desirable to first heat the cylindrical chambers; it can best be done by filling the utensil to be placed therein with boiling hot water and allowing it to remain there as long as convenient. The heat absorbed from the water by the cooker reduces the amount of heat which will be taken up from the food which is later placed therein. The space between the top and inner cover may also be filled with a quilted cover, or any convenient piece of cloth or rug, which will further prevent the evaporation of heat at the top. The space between the kettle and the sides of the cylindrical chamber may also be filled to advantage with old papers, or what is better, a quilted wrapper may be made which will exactly fill the space.

In using the cooker it is necessary to keep in mind that the process of cooking is slower than when using a stove, but over-cooking is not detrimental, in fact, over-cooking is almost an impossibility. It may also be stated that the advantages of a cooker are much greater than at first thought may seem possible. Readers of the magazine who are desirous of helping the feminine portion of the family to save work are earnestly advised to make a cooker as here described, as by means of one kitchen work in the summer can be made much easier and more comfortable. Food can also be reheated in the morning to serve warm at night.

TYPES OF BATTERIES TO USE.

Each style of battery has certain fields of its own to fill but it becomes necessary for the owner of a gasoline engine to decide which he shall use, says the "Canadian Thresherman." In favor of the dry battery is the low cost and the fact that there is no solution to spill around, and the weight is light compared to the wet cells. The objection to them is that they cannot be used on long runs without weakening and then have to stand over night to recuperate.

The proper way to use them is to have two sets, making a double battery and have them connected to a throw switch. This enables you to run a few hours on one set and then throw in the other set and while it is being used the first is regaining its strength. With a wet battery this is not necessary as they continue to give a steady, equal spark until they give out almost at once. On account of this fact it is not necessary to use a double battery with them. Wet battery manufacturers can supply a special style that is liquid tight, but any of the ordinary types can be made so by wrapping the joint of the cover with common electric tape.

Liquid tight cells are required for engines that are moved around so that the jarring and shaking will not spill the liquid. In our opinion the best method of ignition is to use a battery for starting the engine, and by means of a double throw switch, throwing from the battery to an automatic sparking dynamo, after the engine is up to speed. As made now, the high grade dynamos give good results and are to be depended on for a good hot spark that will ignite charges, the battery will sometimes fail to do. The ignition part of an engine is of the utmost importance and must get frequent attention and care to get good results from it.

LITTLE DROPS OF KNOWLEDGE.

One of the commonest excuses which we are all apt to make when we do not know anything, says the "Practical Engineer," is the plea that we have not had the time to look it up because our other duties have engrossed our time. Hundreds of men, young and old, have thus cheated themselves with the notion that they would do some desirable thing if they only had the time.

The truth is, however, that the busiest of us could find leisure for doing the extra things by utilizing the odd chinks and crevices of time and turning them from idle moments into drops of useful knowledge and self-improvement. It is not the man who is surrounded by a luxurious library with whole days of leisure on his hands who makes the most of his opportunities. It is rather the man who, whenever he gets the chance to get hold of a book, will, for the five or ten minutes' leisure that he may have, bathe in its intellectual riches

and bring up facts that can never be loosened from his grasp.

In estimating the time which a man can give to self-improvement, it has been figured out that if the average man lives to be 70 years old, or for 25,500 days, he will have only about 4000 days left at his disposal for direct intellectual development. Surely, then, in looking over the field of successful men it can truly be said that it has been the little drops of knowledge with the added grains of sense that have made this country mighty and its engineering achievements so immense.

INDUSTRIAL SCHOOLS IN BELGIUM.

Consul McNally, of Liege, says that in no country in the world does the government attach more importance to the industrial and professional education of its people than Belgium. While some of the industrial and professional institutions are maintained by the grace of the central government, more are subsidized by the provincial or communal administrations. The city of Liege supports one large industrial school and nine professional schools.

The industrial school is one of the best in Belgium, and has at present an attendance of 650 pupils. Many of its graduates have become noted in the industrial world.

The professional schools include one for tailors, where the lectures and practical work of a tailor as taught in conjunction are free. The course is five years. The school of horticulture is free, with a course of three years.

The commercial and consular high school is intended to offer an advanced education, both theoretical and practical, and is open to those contemplating the profession of banking, commerce, industry, or a consular career. The government usually drafts from the graduates the young men wanted in the various consulates throughout the world, where they remain without compensation during a preliminary prescribed period.

The firearm school was established in 1897, and like the other schools the applicant for admission must have had a primary education. Every detail from the stock making to the barrel is taught, and the boys must pass an apprenticeship in every branch of the gun-making industry. The lectures include both the theory and practical information of firearm making.

The remaining schools embrace tanning, house-painting, mechanics, plumbing and carpenter work. The mechanical school includes the study of political economy, hygiene, arithmetic, geometry, drawing (mechanical), physics, chemistry, mechanics, wood and iron work, bicycle and automobile making.

Plumbing is the only school in which an entrance fee is demanded.

Note the premium offer on editorial page.

CORRESPONDENCE.

No. 143. MERIDEN, CONN. MAY 3, 1905.

Will you kindly advise me whether it would be feasible to light my residence with a small lighting plant operated by myself. I have but little acquaintance with electrical matters and would not feel like investing any considerable sum in an outfit which required constant attendance by a skilled electrician. Would it be of any advantage if several of my neighbors combined with me and a larger plant was purchased? My residence is located some miles from the center of the city and the lighting company does not seem disposed to extend the wires the distance required to supply the section where I am living. H. S. C.

Isolated or self-contained lighting plants are now becoming quite common throughout the country, and if the first cost is not objectionable, a private lighting plant is both satisfactory and inexpensive to operate. The cost of lighting could undoubtedly be made much less than the rates required by the regular lighting company. You do not state the number of lights required, so exact cost of outfit cannot be given. Assuming that the residence contains ten rooms and that twenty lights would be the maximum load, the required output from the dynamo would be about 1000 watts, and a 2-k. w. dynamo would be desirable, running the same with a 3-h. p. gasoline engine. The cost of engine, dynamo, switchboard and switchboard instruments would be approximately $350 or $400.

Owing to the fact that the lamps can be lighted only when the dynamo is in operation, it would also be desirable to have a storage battery, and to keep the number of cells of the battery as small as possible a 55-volt current should be used. Thirty cells in the battery would then be sufficient, which would give two spare cells for use when the battery was nearly run down. Lamps of standard size can be obtained at about the same cost as for the usual lighting circuit voltage, 110 volts.

With a storage battery the size of the dynamo could be reduced to 1 k. w. and a smaller engine used, and the "peak of the load" between five and eight P. M. could be taken care of by the battery. With such an outfit the dynamo could be operated at any convenient time during the day or evening for charging the battery, and the lighting current drawn direct from battery. This would permit of the lamps being lighted at any time of the night, whether the dynamo was in operation or not. When the full number of lamps are required to be lighted, the current could be taken from both dynamo and battery.

Undoubtedly some young man could be found in your vicinity sufficiently acquainted with the operation of a simple outfit of this kind who would operate it for a limited time until you acquire sufficient experience to dispense with his services. Such lighting plants are very desirable and economical for any one willing to devote a small portion of their time to

looking after its maintainance and operation. The expense of operation would be very small, costing not more than two or three cents per thousand watts as against 15 or 18 cents charged by the regular lighting companies.

No. 144. SEATTLE, WASH., MAY 6, 1906.

I recently saw a small model ship enclosed in a glass bottle and would like to know by what process the ship was constructed and placed in the bottle. The ship was considerably larger than the mouth of the bottle, and the bottle did not show any break so that, apparently, the model must have been made in pieces and put together inside of the bottle, which would have been a very difficult operation. Was it not done in some other way, and how? H. T. W.

Models contained in bottles are frequently constructed in the way you state. They are also made up outside of the bottle; the bottom of the bottle is broken off in a special way and then remelted on so skilfully that no trace of the joint appears. Another way is to have bottles made with the neck unshaped, and after the model is placed inside the necks are drawn down to the usual small size.

No. 145. CHICAGO, ILL., MAY, 1906.

Some years ago the newspapers of this city mentioned an invention of an explosive which could be fired from high powered guns, and which was unexplosive until it came in contact with water, when it exploded with great violence. Since then I have heard nothing more of the matter, but am interested to know what substances explode upon coming in contact with water. J. W. C.

Two substances which will explode or give a semblance of explosion upon contact with water; these are the alkali metals, potassium and sodium. If a small piece of either metal is brought into contact with a small portion of water the water decomposes the metal evolving hydrogen and the heat of the reaction is so great that the gas takes fire with a slight explosion.

If potassium be thrown into water, the hydrogen given off will take fire, but this is not true of sodium which has a less powerful reaction and does not produce a sufficiently high temperature to ignite gas when brought in contact with a large quantity of water. In handling both metals great care must be used, as the moisture of the fingers will frequently cause them to unite. They must also be kept in air-tight receptacles, as they oxidize rapidly when exposed to moist air. Presumably the explosive you mention as being reported in the papers was some high explosive which was exploded by means of one of the two metals here mentioned, as neither of these two metals would have caused an explosion of sufficient violence to be valuable for commercial purposes in warfare.

No. 146. NEWARK, N. J., MAY 8, 1906.

Will you kindly advise if it is possible to solder a leak in a lead pipe in through which water is flowing. A. L. R.

It is not possible to solder lead pipes containing water, as the heat of the solder is drawn off so rapidly that it will chill on coming in contact with the pipe. We presume that for some reason it is not desirable to shut off the water, in which case the only way in which the pipe can be soldered is as follows:—Cut off the pipe at the leak with a hack saw and fill the feed end with a "stop back" made of very soft well kneaded clay or piece of soft bread or dough. This stopback should be forced 6 or 8 in. from the end of pipe. The pipe can then be soldered as usual, using a flux. Care must be taken not to have the stop back so hard as to prevent the water from eventually soaking through it and forcing a passage.

If it is possible to run a stout string through the empty section of the pipe, the end of the string could be carried through the stop back. After the joint is soldered, pull out the string, leave a small hole and the water will pass through it and eventually clear out the pipe.

No. 147. PHILADELPHIA, PA., MAY. 4, 1906.

I am using a magneto to spark a small gas engine. The spark is quite feeble and the magneto does not seem to be giving a very strong current. Will you please inform me what may be the matter with it? G. E. M.

Magneto igniters are constructed with permanent magnets. The magnetism in such magnets becomes weak in time and they require to be remagnetized. If you are acquainted with any one in an electric lighting station you could probably take the magnets to the station and have them remagnetized. There are also electrical manufacturing concerns in your city who could do it for you at small expense. It would be well to thoroughly examine the spark plugs and all connections to ascertain if the fault really is with the igniter, as it frequently happens that a poor connection or spark plug will cause trouble which may seem to be with some other part of the sparking apparatus.

To find the diameter of a driven pulley, when diameter and speed of driver and speed required are known, multiply the diameter of the driver by its speed of revolution, divide by the required speed; result will be the diameter of the driven pulley. To find the speed of a driven shaft when the speed of driver, diameter of driver, and diameter of driven pulley are known, multiply the speed of the driver by its diameter and divide by the diameter of the driven pulley; the result will be the speed of the driven pulley. To find the diameter of driver when the diameter of the driven are known, multiply the speed of the driven pulley by its diameter and divide by the speed of the driver; the result will be the diameter.

SCIENCE AND INDUSTRY.

Interposing low pressure steam turbines between reciprocating engines and their condensers is becoming an increasing custom. The provision of a producer and a gas engine in lieu of a steam plant for propulsion purposes on freight boats in Germany is also attracting attention. Eleven of these boats, carrying 240 tons of freight each, have been thus equipped. The fuel consumption has been found to be only 1.32 pounds of anthracite coal per h. p. hour.

To remove rust from steel, immerse the article to be cleaned in a strong solution of cyanide of potassium. Mix to the consistency of thick cream a paste of cyanide potassium, castile soap, whitening and water, and after immersion, brush the steel briskly, using the paste.

A fatal accident in a San Francisco sewer, due to the presence of foul air in a dead end, again calls attention to the necessity of care in entering such places unless it is known that they are properly ventilated. It sometimes happens that in old combined sewers an opportunity is afforded for foul air to collect, and anyone who enters such a pocket does so at the risk of death. In the San Francisco case a workman entered such a dead end in order to clean out a connecting sewer entering it. He was overcome by the gases and lost his life, and several men who entered the sewer to recover his body barely escaped. Such places in a sewerage system should not exist, but as they still remain in some cities, effective precautions should be taken to prevent any such fatalities to the men who must work in them.

The flaming arc lamp was rather late in securing a footing in this country, but is now receiving enough careful study by American electricical engineers to afford definite information before long concerning its place among our illuminating apparatus, says the "Engineering Record." Its brilliant light, yellow, white or pink, makes it an astonishing sight, while its efficiency is equally surprising. It gives from five to ten times as much light per watt as the common enclosed arc lamp, and bids fair to become as cheap as any illuminant. At present it labors under the disadvantage of evolving such a quantity of fumes that its use indoors is unadvisable until some remedy for this condition is found. It must also be trimmed more often than the enclosed arc lamp, being on a par with the open arc in this respect.

The "Boiler Maker" gives the following receipt for steam fitters' cement. Dissolve one part, by weight, rubber or gutta percha in sufficient carbon disulphide to give it the consistency of molasses, then mix with six parts, by weight, linseed oil and leave exposed to the air for twenty four hours; then mix to a putty with red lead. A less brittle cement is made by using oxide of iron in place of red lead.

When made in thin sheets, gold has remarkable properties, says the "Engineer." Gold leaf used by decorators is transparent, and the light which passes through it is green. If, however, a film of the metal thinner than this is obtained, its color by transmitted light inclines to blue purple. If these thin films are subjected to an annealing process, below the melting point of gold, the transparency is much increased and the color varies from pale brown to pale pink.

Progress in mechanical flight is slow but sure, says the "Engineer." Orville and Wilbur Wright have for three years been experimenting with inclined curved surfaces, first in gliding flight and more recently, with newer propulsion. Last fall they succeeded in making flights of 20 miles made up of straight lines, circles and ellipses, with and against a stiff breeze and in calm weather. The weight of machine and operator was 629 pounds and the gasoline engine used was a 34 h. p. air-cooled, four cylinder machine. Several eye-witnesses have substantially corroborated the statements of the Messrs. Wright in regard to these flights which were made near Dayton, O. This achievement which has recently been announced to the Aero Club of America seems to mark distinctly the beginning of successful mechanical flight by a power driven machine carrying a man.

A circular of the Crude Oil Power Co. 101 Life Building, Kansas City, Mo., is interesting in explaining a device handled to furnish the source of power for gas engines. The mechanism and principle involves a horizontal rotating drum with interior spiral ribs, enclosed in an outer casing. The crude oil enters the drum at one end, and by rotation and the spiral ribs, is carried slowly and uniformly through it. While the oil is passing through the drum it is exposed to sufficient heat to generate gas, which is drawn off and utilized by the engine in proportion to the amount generated and the residue is discharged.

The heat is supplied by the exhaust of the engine, which passes between the drum and the outer shell, keeps the drum at a certain temperature, just high enough to get all the gas out of the oil. The rotating drum stirs up the oil, turns it over, carries it in a thin sheet up on the sides of the drum and exposes it to the heat. This is the best method of generating gas from crude oil. By it the gas is generated without an excessive amount of heat, the residue is discharged as soon as the gas is extracted, thereby obviating the necessity of the continuous cleaning heretofore necessary, while it insures a regular uniform supply of gas to the engine. Owing to the difference in cost between gasoline and crude oil, comparing as some 18 to 4 cents, and it is stated one gallon of crude oil will develop nearly as much power as a corresponding amount of gasoline, the bringing of this California practice East deserves attention.

"The poorest workmen have more to talk about than a busy man."